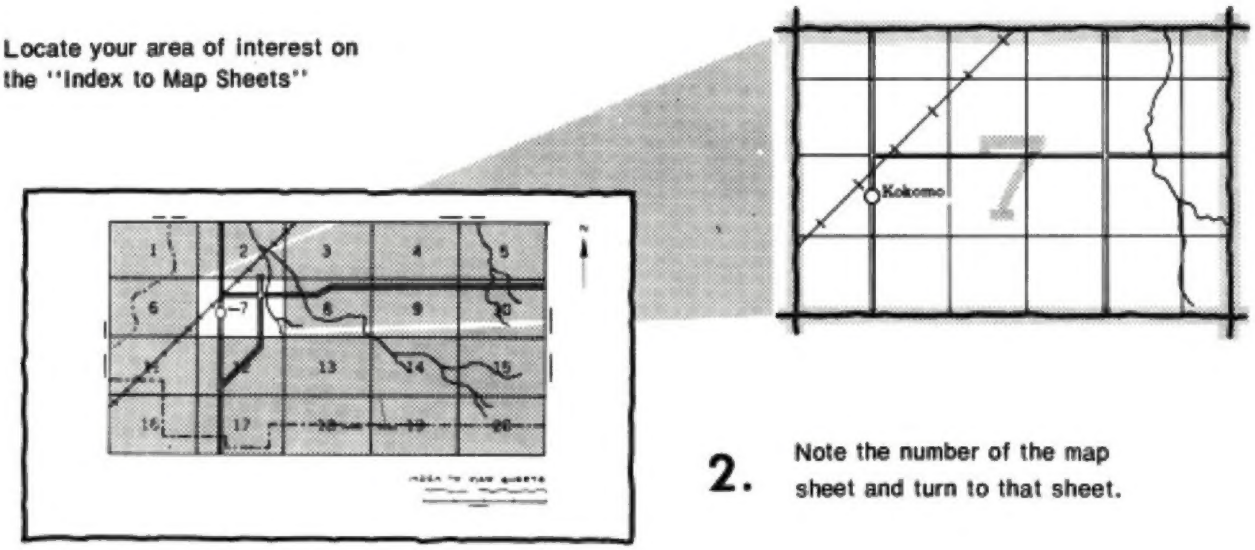
SOIL SURVEY OF

KENDALL COUNTY, TEXAS

United States Department of Agriculture, Soil Conservation Service
in cooperation with Texas Agricultural Experiment Station

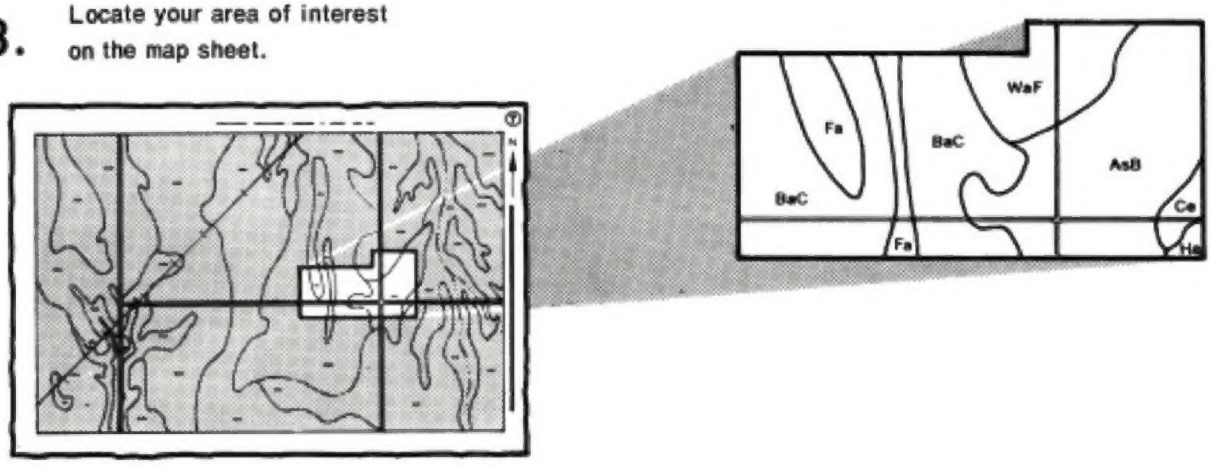
HOW TO USE

1. Locate your area of interest on the "Index to Map Sheets"

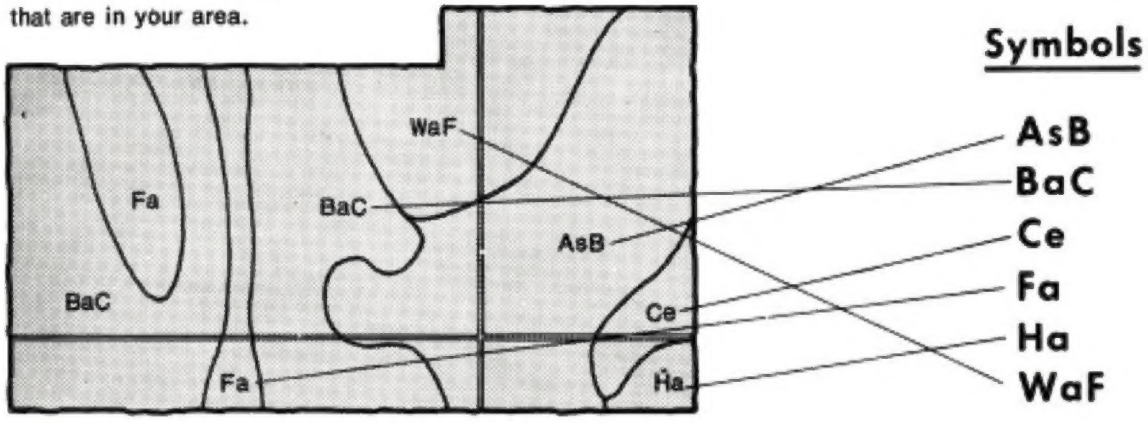


2. Note the number of the map sheet and turn to that sheet.

3. Locate your area of interest on the map sheet.

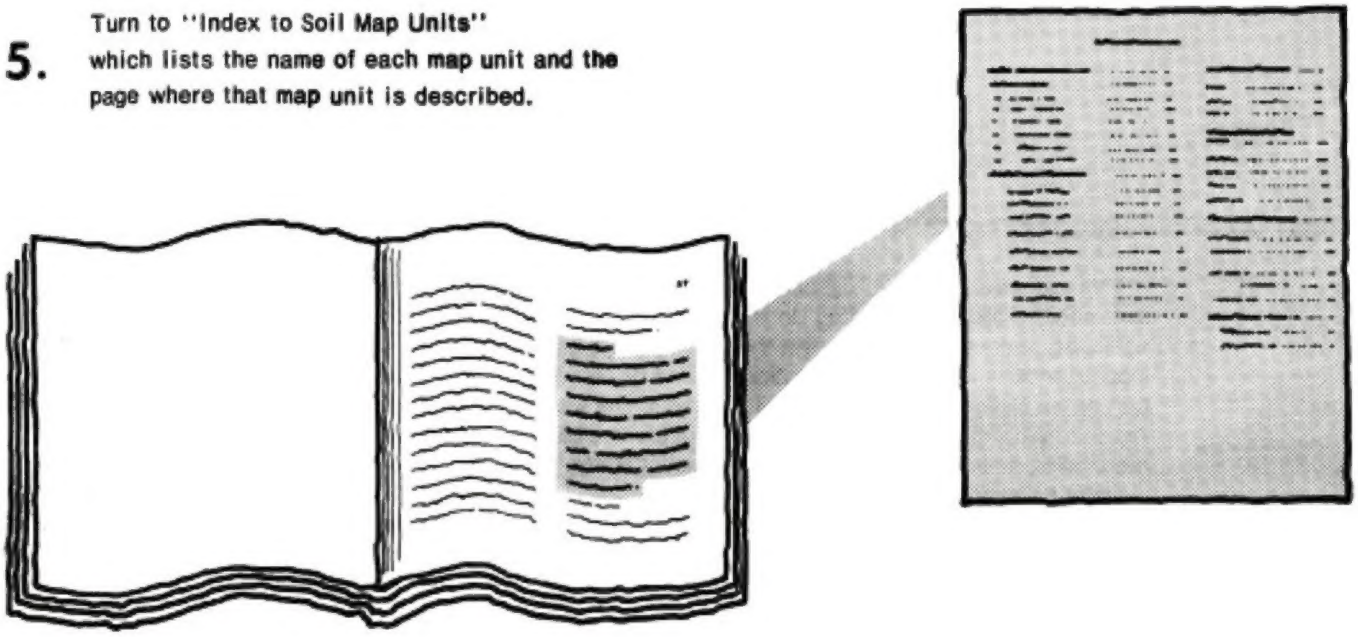


4. List the map unit symbols that are in your area.

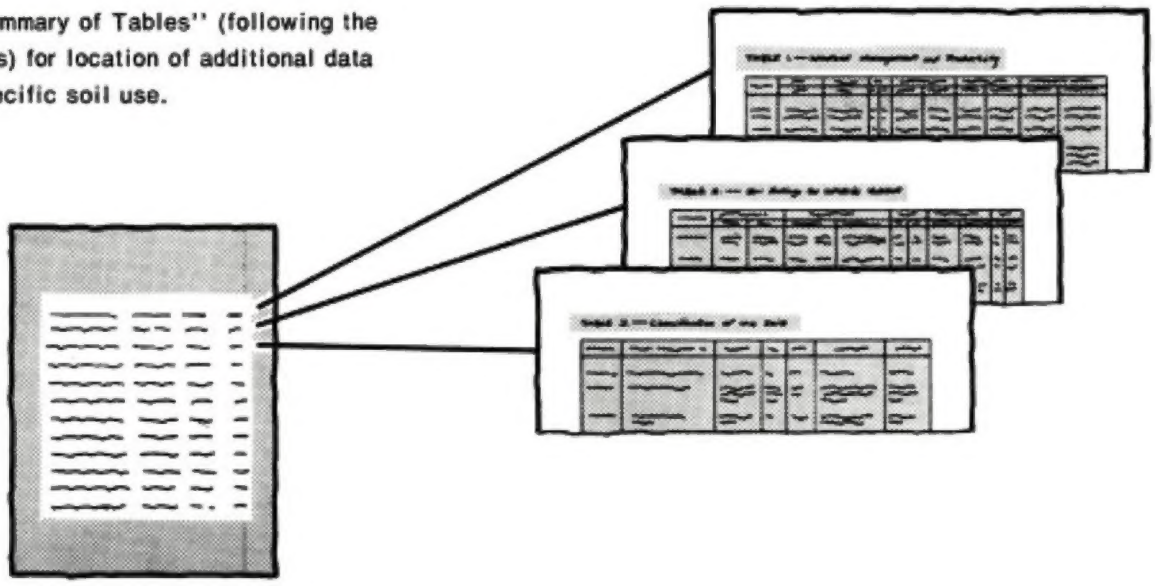


THIS SOIL SURVEY

5. Turn to "Index to Soil Map Units" which lists the name of each map unit and the page where that map unit is described.



6. See "Summary of Tables" (following the Contents) for location of additional data on a specific soil use.



7. Consult "Contents" for parts of the publication that will meet your specific needs. This survey contains useful information for farmers or ranchers, foresters or agronomists; for planners, community decision makers, engineers, developers, builders, or homebuyers; for conservationists, recreationists, teachers, or students; to specialists in wildlife management, waste disposal, or pollution control.

This soil survey is a publication of the National Cooperative Soil Survey, a joint effort of the United States Department of Agriculture and other federal agencies, state agencies including the Agricultural Experiment Stations, and local agencies. The Soil Conservation Service has leadership for the federal part of the National Cooperative Soil Survey. In line with Department of Agriculture policies, benefits of this program are available to all, regardless of race, color, national origin, sex, religion, marital status, or age.

Major fieldwork for this soil survey was performed in the period 1972-1978. Soil names and descriptions were approved in 1979. Unless otherwise indicated, statements in this publication refer to conditions in the survey area in 1979. This survey was made cooperatively by the Soil Conservation Service and the Texas Agricultural Experiment Station. It is part of the technical assistance furnished to the Kendall Soil and Water Conservation District.

Cover: The landscape of Kendall County is dominantly hills and valleys. The deeper and more productive Barbarosa, Krum, Nuvalde, and Oakalla soils are in the valleys. On the hills are Comfort, Eckrant, Brackett, and Real soils.

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soil series

Issued March 1981

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foreword

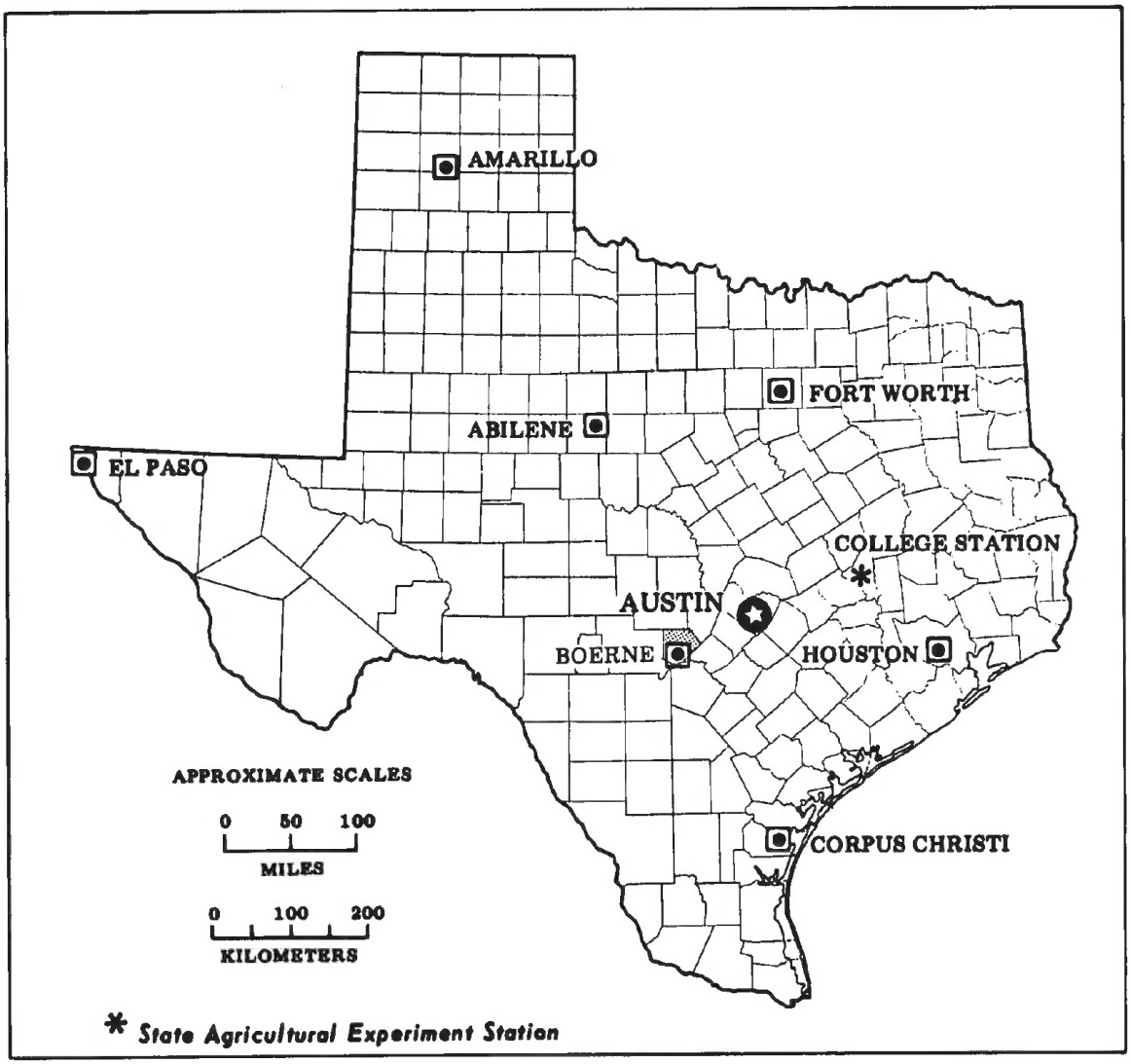
This soil survey contains information that can be used in land-planning programs in Kendall County. It contains predictions of soil behavior for selected land uses. The survey also highlights limitations and hazards inherent in the soil, improvements needed to overcome the limitations, and the impact of selected land uses on the environment.

This soil survey is designed for many different users. Farmers, ranchers, and agronomists can use it to evaluate the potential of the soil and the management needed for maximum food and fiber production. Planners, community officials, engineers, developers, builders, and home buyers can use the survey to plan land use, select sites for construction, and identify special practices needed to insure proper performance. Conservationists, teachers, students, and specialists in recreation, wildlife management, waste disposal, and pollution control can use the survey to help them understand, protect, and enhance the environment.

Great differences in soil properties can occur within short distances. Some soils are subject to flooding. Some are shallow to bedrock. Some are too unstable to be used as a foundation for buildings or roads. Clayey soils are poorly suited to use as septic tank absorption fields. A high water table makes a soil poorly suited to basements or underground installations.

These and many other soil properties that affect land use are described in this soil survey. Broad areas of soils are shown on the general soil map. The location of each soil is shown on the detailed soil maps. Each soil in the survey area is described. Information on specific uses is given for each soil. Help in using this publication and additional information are available at the local office of the Soil Conservation Service or the Cooperative Extension Service.

George C. Marks
State Conservationist
Soil Conservation Service



Location of Kendall County in Texas.

soil survey of
Kendall County, Texas

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Soil Conservation Service

United States Department of Agriculture, Soil Conservation Service
in cooperation with
Texas Agricultural Experiment Station

KENDALL COUNTY is in the south-central part of Texas on the southern edge of the Edwards Plateau. It is bordered on the north by Gillespie County, on the northeast by Blanco County, and on the southeast by Comal County. Balcones Creek separates Kendall County from Bexar County to the south. On the southwest, Kendall County is bordered by Bandera County, and on the west it is bordered by Kerr County. Boerne, the county seat, is about 34 miles north of San Antonio. Comfort, Bergheim, Kendalia, Sisterdale, Waring, and Welfare are other communities in the county.

Kendall County is irregular in shape, measuring about 29 miles from north to south and about 30 miles from east to west. The total area is 670 square miles, or 428,800 acres. The Guadalupe River crosses the county from east to west. The Blanco River originates in the northeastern corner of the county. Cibolo Creek, Curry Creek, Ranger Creek, Big Joshua Creek, and Sister Creek are some of the other streams in the county.

In 1978, according to records of the Boerne field office of the Soil Conservation Service, approximately 373,450 acres was used as rangeland; 36,000 acres as cropland; 10,350 acres as pastureland; and 9,000 acres as urban and built-up land in the county.

The landscape of Kendall County is made up of a series of long, low, and narrow hills. The hillsides have a stairstepped appearance as a result of the differences in hardness and resistance to erosion and weathering of the alternating layers of limestone and marl.

Points of interest in the county are the Guadalupe River, Cascade Cavern, the "Cave Without A Name," and Robert E. Lee's former headquarters in Boerne.

Land in the county is rapidly being sold and developed as homesites, mainly by people from the nearby city of San Antonio.

The Kendall Soil and Water Conservation District, Kendall County, and the city of Boerne sponsor a flood control program program for the Cibolo Creek Watershed. One dam, Site 1 Upper Cibolo Creek, has been completed as a multiple purpose structure. This structure provides municipal water, flood control, and recreation. The construction of three other structures is planned for this watershed.

Descriptions, names, and delineations of soils in this soil survey do not fully agree with those on soil maps for adjacent counties. Differences are the result of better knowledge of soils, modifications in series concepts, intensity of mapping, or the extent of the soils within the survey area.

general nature of the county

This section gives information that will be most useful to persons not familiar with the survey area. It describes the climate of the county and gives other information about history, transportation, and natural resources.

climate

Prepared by the National Climatic Center, Asheville, North Carolina.

Table 1 gives data on temperature and precipitation for the survey area as recorded at Kerrville in the period 1951 to 1974. Table 2 shows probable dates of the first freeze in fall and the last freeze in spring. Table 3 provides data on length of the growing season.

In winter the average temperature is 47 degrees F, and the average daily minimum temperature is 33 degrees. The lowest temperature on record, which occurred at Kerrville on February 2, 1951, is -2 degrees. In summer the average temperature is 80 degrees, and the average daily maximum temperature is 92 degrees. The highest recorded temperature, which occurred at Kerrville on July 27, 1954, is 110 degrees.

Growing degree days are shown in table 1. They are equivalent to "heat units." During the month, growing degree days accumulate by the amount that the average temperature each day exceeds a base temperature (50 degrees F). The normal monthly accumulation is used to schedule single or successive plantings of a crop between the last freeze in spring and the first freeze in fall.

The total annual precipitation is about 30 inches. Of this, 17 inches, or 60 percent, usually falls in April through September, which includes the growing season for most crops. In 2 years out of 10, the rainfall in April through September is less than 12 inches.

Snowfall is rare. In 75 percent of the winters, there is no measurable snowfall. In 20 percent, the snowfall, usually of short duration, is more than 2 inches. The heaviest 1-day snowfall on record was more than 6 inches.

The average relative humidity in midafternoon is about 60 percent. Humidity is higher at night, and the average at dawn is about 80 percent. The sun shines 70 percent of the time possible in summer and 50 percent in winter. The prevailing wind is from the southeast. Average windspeed is highest, 11 miles per hour, in spring.

history

The first inhabitants of the area were the Indians who roamed the hills and valleys. Then came the Spaniards and Mexicans, whose influence is seen in such names as the Guadalupe River and Cibolo Creek.

The greatest influence on the county, however, was from settlers of German extraction who came to Boerne in 1849. The city of Comfort was founded in 1854. The settlers were attracted by the many springs and flowing streams, favorable climate, and abundance of grass for raising cattle and sheep. The soils in the valleys were fertile and were used to grow food for the settlers and feed for their livestock. The trees furnished wood for fuel and lumber for homes.

Kendall County was established in 1862 by the Texas Legislature from parts of Bexar, Blanco, Comal, and Kerr Counties. The county was named for George Wilkins Kendall who brought in a hardy flock of Mexican ewes. He also brought in sheep from Vermont, thereby introducing Merino sheep to the area.

In 1887, with the extension of a railroad line into Kerrville, the agricultural development of the Guadalupe River valley was made possible. Much land was cleared and cultivated. By 1915, most of the land that was suited to farming was in production.

transportation

Interstate Highway 10 and U.S. Highway 87 are major roads in Kendall County. Texas Highway 46 and a network of ranch roads are excellent for automobile and truck traffic.

natural resources

Kendall County has an abundant supply of rock for use as building and road material. There are abundant supplies of good quality water from springs, streams, and wells. Most of the deep soils in the valleys are suited to cropland and pastureland. No oil or gas has been produced in the county. White-tailed deer, turkeys, quail, and doves are a source of income for many ranchers in the county.

how this survey was made

Soil scientists made this survey to learn what soils are in the survey area, where they are, and how they can be used. They observed the steepness, length, and shape of slopes; the size of streams and the general pattern of drainage; the kinds of native plants or crops; and the kinds of rock. They dug many holes to study soil profiles. A profile is the sequence of natural layers, or horizons, in a soil. It extends from the surface down into the parent material, which has been changed very little by leaching or by plant roots.

The soil scientists recorded the characteristics of the profiles they studied and compared those profiles with others in nearby counties and in more distant places. They classified and named the soils according to nationwide uniform procedures. They drew the boundaries of the soils on aerial photographs. These photographs show trees, buildings, fields, roads, and other details that help in drawing boundaries accurately. The soil maps at the back of this publication were prepared from aerial photographs.

The areas shown on a soil map are called map units. Most map units are made up of one kind of soil. Some are made up of two or more kinds. The map units in this survey area are described under "General soil map units" and "Detailed soil map units."

While a soil survey is in progress, samples of some soils are taken for laboratory measurements and for engineering tests. All soils are field tested to determine their characteristics. Interpretations of those characteristics may be modified during the survey. Data are assembled from other sources, such as test results, records, field experience, and state and local specialists. For example, data on crop yields under defined management are assembled from farm records and from field or plot experiments on the same kinds of soil.

But only part of a soil survey is done when the soils have been named, described, interpreted, and delineated

on aerial photographs and when the laboratory data and other data have been assembled. The mass of detailed information then needs to be organized so that it can be used by farmers, rangeland managers, engineers, planners, developers and builders, home buyers, and others.

general soil map units

The general soil map at the back of this publication shows broad areas that have a distinctive pattern of soils, relief, and drainage. Each map unit on the general soil map is a unique natural landscape. Typically, a map unit consists of one or more major soils and some minor soils. It is named for the major soils. The soils making up one unit can occur in other units but in a different pattern.

The general soil map can be used to compare the suitability of large areas for general land uses. Areas of suitable soils can be identified on the map. Likewise, areas where the soils are not suitable can be identified.

Because of its small scale, the map is not suitable for planning the management of a farm or field or for selecting a site for a road or building or other structure. The soils in any one map unit differ from place to place in slope, depth, drainage, and other characteristics that affect management.

1. Brackett-Eckrant

Shallow and very shallow, undulating to hilly, loamy and clayey soils; most are gravelly or stony; on uplands

These undulating to hilly soils are on ridges and hills. They are underlain by limestone or limestone interbedded with marl. Because the limestone layers are more resistant to weathering than the marl layers, the ridges and series of long hills that these soils occupy have a stairstepped, or benched, appearance with narrow valleys between. Slopes range from 1 to 30 percent. Common trees are live oak, Texas oak, and Ashe juniper.

This map unit makes up about 50 percent of the county. It is about 35 percent Brackett soils, 25 percent Eckrant soils, and 40 percent Doss, Krum, and Real soils and Rock outcrop. Doss soils are on less sloping parts of hills. Krum soils are in upland valleys that are tributaries to streams. Real soils are continuous bands on sides of the hills perpendicular to the slopes. Rock outcrops are mainly ledges within areas of Eckrant soils.

Brackett soils are on the sides of hills and ridges. Typically, they have a surface layer of light brownish gray gravelly clay loam about 6 inches thick. The layer between 6 and 14 inches is light brownish gray clay loam that contains soft bodies of calcium carbonate. This layer rests on weakly cemented limestone interbedded with white Cretaceous marl.

Eckrant soils are on sides of hills, mostly on northeast-facing slopes. Typically, they have a surface layer of very dark gray stony clay 14 inches thick. This layer rests abruptly on hard, fractured limestone.

The soils in this map unit are poorly suited to cultivated crops because of shallow rooting depth, low available water capacity, steep slopes, and stoniness. They are moderately well suited to rangeland. Shallow rooting depth, rapid runoff, low available water capacity, stoniness, and steep slopes are the most limiting features. These soils are poorly suited to urban and recreation uses because of shallow depth to rock and steep slopes. They are poorly suited to sanitary facilites because of shallow depth to rock, steep slopes, and moderately slow permeability.

2. Doss-Brackett

Shallow, undulating, loamy and clayey soils; on uplands

The soils in this map unit are underlain by limestone and marl. Because the limestone layers are more resistant to weathering than the marl layers, the series of low hills that these soils occupy has a stairstepped, or benched, appearance. Slopes range from 1 to 8 percent. Trees occur in mottes of live oak and Ashe juniper.

This map unit makes up 20 percent of the county. It is 50 percent Doss soils, 25 percent Brackett soils, and 25 percent Krum and Denton soils and Rock outcrop. Denton soils are on sides of upland valleys. Krum soils are in upland valleys that are tributaries to streams. Rock outcrops are on the edges of benches.

Doss soils are on the less sloping, lower parts of low hills. Typically, they have a surface layer of dark grayish brown silty clay 9 inches thick. The layer between 9 and 18 inches is brown silty clay that contains small bodies of calcium carbonate. This layer rests on a thick layer of marl and weakly cemented caliche.

Brackett soils are on the more sloping parts and tops of low hills. Typically, they have a surface layer of light brownish gray clay loam about 7 inches thick. The layer between 7 and 19 inches is very pale brown clay loam that contains about 20 percent by volume soft and weakly cemented bodies of calcium carbonate. This layer rests on thinly interbedded, weakly cemented limestone and marl.

The Doss soils are suited to cultivation. The Brackett soils are poorly suited to cultivated crops because of shallow depth to rock, small stones, shallow rooting depth, and low available water capacity. The soils in this map unit are moderately well suited to rangeland.

Shallow rooting depth, rapid runoff, low available water capacity, and small stones are the most limiting features. These soils are poorly suited to urban and recreation uses because of shallow depth to rock. They are poorly suited to sanitary facilities because of shallow depth to rock and moderately slow permeability. The soils in this map unit are better suited to native rangeland and wildlife habitat than to most other uses.

3. Eckrant-Comfort-Tarpley

Very shallow and shallow, gently undulating, clayey soils; most are stony; on uplands

These gently undulating soils are on a broad plateau and are underlain by limestone. Slopes range from 1 to 5 percent. Common trees are live oak and Ashe juniper.

This map unit makes up 20 percent of the county. It is about 30 percent Eckrant soils, 22 percent Comfort soils, 20 percent Tarpley soils, and 28 percent Anhalt and Doss soils and Rock outcrop. Anhalt soils are on foot slopes. Doss soils formed in outcrops of soft limestone. Rock outcrops are in all soil areas.

Eckrant soils are on ridges, slightly higher than the surrounding Tarpley soils. Typically, Eckrant soils have a surface layer of very dark gray stony clay about 5 inches thick. This layer rests abruptly on indurated, fractured limestone bedrock. This soil has pebbles, cobbles, and stones on the surface. Rock outcrops are in areas of this Eckrant soil. Areas of Rock outcrop and areas of soil covered by rock fragments make up 20 to 50 percent of the area mapped as Eckrant soils.

Comfort soils are on ridgetops and plane surfaces just below Eckrant soils. Typically, Comfort soils have a surface layer of dark grayish brown stony clay about 5 inches thick. The layer between 5 and 17 inches is dark reddish gray stony clay. This layer is underlain by indurated limestone bedrock.

Tarpley soils are in similar positions to the Comfort soils. Typically, Tarpley soils have a surface layer of dark reddish brown stony clay 8 inches thick. The layer between 8 and 19 inches is reddish brown clay. This layer rests abruptly on indurated, fractured limestone.

The soils in this map unit are poorly suited to cultivated crops because of shallow rooting depth, low available water capacity, and stoniness. A few areas of non-stony Tarpley soils are planted to small grain, grain sorghum, and forage sorghum. Most areas of this map unit are used as native rangeland. These soils are moderately well suited to rangeland. Shallow rooting depth, rapid runoff, low available water capacity, and slopes are the most limiting features. These soils are poorly suited to urban use because of shallow depth to limestone bedrock, stoniness, and corrosivity to uncoated steel. They are poorly suited to recreation uses because of shallow depth to limestone bedrock, slow permeability, stoniness, and a clayey surface texture. These soils are poorly suited to sanitary facilities because of shallow depth to limestone bedrock and slow permeability.

4. Oakalla-Boerne-Nuvalde

Deep, nearly level to gently sloping, loamy and clayey soils; on flood plains and stream terraces

The soils in this map unit are on flood plains, foot slopes, and stream terraces below limestone hills. Slopes range from 0 to 5 percent. Common trees are live oak, elm, pecan, and baldcypress.

This map unit makes up 10 percent of the county. It is 23 percent Oakalla soils, 18 percent Boerne soils, 17 percent Nuvalde soils, and 42 percent small areas of Barbarosa, Denton, Krum, and Orif soils. Barbarosa, Denton, and Krum soils are on terraces. Orif soils are on flood plains.

Oakalla soils are in long, narrow areas on flood plains. Typically, the surface layer is very dark gray silty clay loam about 15 inches thick. From a depth of 15 to 60 inches is silty clay loam that is dark grayish brown in the upper part, brown in the middle part, and grayish brown in the lower part.

Boerne soils are in long, narrow, convex areas on flood plains. Typically, the surface layer is grayish brown fine sandy loam 8 inches thick. From a depth of 8 to 60 inches is brownish loam that has soft bodies of calcium carbonate and is usually stratified in the lower part.

Nuvalde soils are on terraces a few feet above the flood plains. Typically, the surface layer is dark brown silty clay 20 inches thick. From a depth of 20 to 60 inches is reddish brown silty clay that grades to yellowish red clay loam in the lower part.

Areas of this map unit are flooded from twice each year to once in 4 years. The soils remain under water for 24 to 48 hours. The current is swift during periods of flooding.

The soils in this map unit are well suited to cultivated crops and moderately well suited to rangeland. Grain sorghum, oats, wheat, and hay are the main crops. These soils are poorly suited to urban uses and sanitary facilities because of flooding. Shrinking and swelling, low strength, cutbanks caving, and corrosivity to uncoated steel are other limitations to urban uses. These soils are moderately well suited to recreation uses. The clayey surface texture, permeability, and flooding are the most limiting features.

broad land use considerations

The soils in Kendall County vary widely in their suitability for major land uses. Table 4 indicates, for each land use, general ratings of the suitability of each map unit in relation to the other map units. Kinds of soil limitations are also indicated in general terms. The ratings of soil suitability reflect the relative cost of such practices and the hazard of continuing soil related problems after such practices are installed. The ratings do not consider location in relation to existing transportation systems or other kinds of facilities.

Kinds of land uses considered include cultivated farm crops, rangeland, urban uses, recreation areas, and

sanitary facilities. Cultivated farm crops grown in the survey area include grain sorghum, oats, and wheat. Rangeland refers to land in native range plants. Urban uses include land used for residential, commercial, and industrial sites. Recreation uses include nature study area trails, wilderness areas, camp areas, picnic areas, and playgrounds. Sanitary facilities include land used for septic tank absorption fields and trench type sanitary landfills.

In 1978, according to records of the Boerne field office of the Soil Conservation Service, about 87 percent of the survey area was rangeland, about 8 percent was used for cultivated farm crops, 3 percent was pasture, and the remaining 2 percent was in urban uses including recreation areas.

The general soil information in this section and more detailed information in the following sections can be used as a guide in planning the orderly growth and development of the county.

detailed soil map units

The map units on the detailed soil maps at the back of this survey represent the soils in the survey area. The map unit descriptions in this section, along with the soil maps, can be used to determine the suitability and potential of a soil for specific uses. They also can be used to plan the management needed for those uses. More information on each map unit, or soil, is given under "Use and management of the soils."

Each map unit on the detailed soil maps represents an area on the landscape and consists of one or more soils for which the unit is named.

This survey was mapped at two levels of detail. At the most detailed level, map units are narrowly defined. This means that soil boundaries were plotted and verified at closely spaced intervals. At the less detailed level, map units are broadly defined. Soil boundaries were plotted and verified at wider intervals. The broadly defined units are indicated by an asterisk in the soil map legend. The detail of mapping was selected to meet the anticipated long-term use of the survey, and the mapping units were designed to meet the needs for that use.

A symbol indentifying the soil precedes the map unit name in the soil descriptions. Each description includes general facts about the soil and gives the principal hazards and limitations to be considered in planning for specific uses.

Soils that have profiles that are almost alike make up a *soil series*. Except for differences in texture of the surface layer or of the underlying material, all the soils of a series have major horizons that are similar in composition, thickness, and arrangement.

Soils of one series can differ in texture of the surface layer or of the underlying material. They also can differ in slope, stoniness, salinity, degree of erosion, and other characteristics that affect their use. On the basis of such differences, a soil series is divided into *soil phases*. Most of the areas shown on the detailed soil maps are phases of soil series. The name of a soil phase commonly indicates a feature that affects use or management. For example, Nuvalde silty clay, 0 to 1 percent slopes, is one of two phases in the Nuvalde series.

Some map units are made up of two or more major soils. These map units are called soil associations.

A *soil association* is made up of two or more geographically associated soils that are shown as one unit on the maps. Because of present or anticipated soil uses in the survey area, it was not considered practical or necessary to map the soils separately. The pattern and relative proportion of the soils are somewhat similar. Brackett-Real association, hilly, is an example.

Table 5 gives the acreage and proportionate extent of each map unit. Other tables (see "Summary of tables") give properties of the soils and the limitations, capabilities, and potentials for many uses. The Glossary defines many of the terms used in describing the soils.

1—Anhalt clay, 1 to 3 percent slopes. This moderately deep, gently sloping soil is on uplands. Slopes are slightly concave and average 2 percent. Mapped areas are irregular in shape and range from 15 to 60 acres. The soil surface in rangeland areas is characterized by gilgai microrelief consisting of microknolls and microdepressions. The microknolls are 6 to 8 inches higher than the microdepressions. They are 2 to 8 feet across and from 3 to 15 feet apart. The gilgai microrelief is smoothed out after a few years of cultivation.

In the center of a microknoll, typically, the surface layer of this soil is dark brown clay about 7 inches thick. The subsoil is dark reddish brown clay that contains intersecting slickensides to a depth of 29 inches. Indurated, fractured limestone is at a depth of 29 inches. Reaction of the surface layer is neutral. Reaction of the subsoil is slightly acid in the upper part and mildly alkaline in the lower part (fig. 1).

This soil is well drained. Surface runoff is medium. When dry, this soil has wide cracks that extend to a depth of 24 inches. Water enters rapidly when the soil is dry and cracked, but very slowly when the soil is wet and the cracks are closed. Permeability is very slow. The available water capacity is low. Natural fertility is high. The root zone is moderately deep, but the clay content of the soil impedes the movement of air and water and the penetration of roots. The hazard of water erosion is moderate.

Tilling this soil continuously at the same depth causes a plowpan to form. Good tilth is difficult to maintain under cultivation. The high content of clay causes the soil to be sticky when wet and very hard and cloddy when dry. This soil is best tilled when soil moisture content is low. The natural structure is then broken apart but not destroyed, and aeration is improved.

Included with this soil in mapping are small, circular areas of Tarpley soils. Also included are soils on knolls that are similar to Anhalt soils but have a surface layer of about 20 percent by volume pebble- and cobble-size

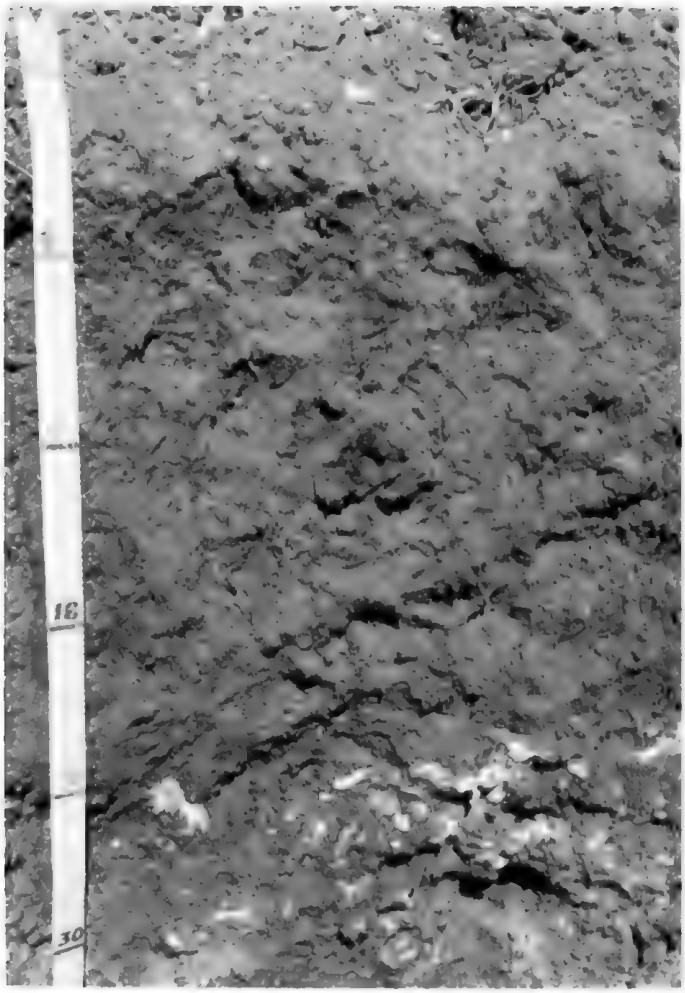

Figure 1.—Profile of Anhalt clay. The parent material is weathered limestone. (The scale is in inches.)

chert fragments. The included soils make up as much as 15 percent of each mapped area.

Areas of this Anhalt soil are used as cropland, improved pastureland, and rangeland.

This soil is moderately well suited to cultivated crops. Very slow permeability and low available water capacity are the most limiting features. Grain sorghum, oats, and wheat are the principal crops. This soil is well suited to improved pastures of bermudagrass.

This soil is poorly suited to most urban uses and to sanitary facilities. Shrinking and swelling, low strength, corrosivity to uncoated steel, and moderate depth to limestone rock are limiting features. Most of these limitations can be overcome by proper design and careful installation. The clayey texture and very slow permeability limit use of this soil for septic tank absorption fields. The absorption area needs to be enlarged or the design modified. This soil is poorly suited to recreation uses. The clayey surface layer and very slow permeability are the most limiting features.

The potential rangeland plant community is a tall grass, post oak savannah. Typically, the dominant plants are—

- little bluestem—30 percent
- indiangrass—15 percent
- sideoats grama—10 percent
- other mid grasses, such as Texas cupgrass, pinhole bluestem, meadow dropseed, vine-mesquite, curlymesquite, and buffalograss—35 percent
- woody plants, such as post oak, blackjack oak, live oak, and greenbrier—5 percent
- forbs, such as Engelmann-daisy, bushsunflower, and sensitivebrier—5 percent

Total annual dry weight forage production per acre on this soil in excellent condition ranges from 5,500 pounds in favorable years to 3,000 pounds in unfavorable years.

Continuous heavy grazing by livestock decreases the proportion of preferred forage plants, such as little bluestem, indiangrass, and Engelmann-daisy. These are replaced by less desirable forage plants, such as sideoats grama, pinhole bluestem, buffalograss, and post oak. If heavy grazing continues for many years, oaks form a dense stand with an understory of such plants as threeawn, Texas wintergrass, Ashe juniper, Texas persimmon, pricklypear, and mesquite.

Areas of this soil provide fair habitat for deer, turkeys, squirrels, and furbearing animals. Nesting areas for doves and songbirds are plentiful.

This Anhalt soil is in capability subclass IIIe and in the Deep Redland range site.

2—Barbarosa silty clay loam, 0 to 1 percent slopes. This deep, nearly level soil is on terraces near the flood plain of the Guadalupe River. The surface is smooth and plane. Mapped areas are long and oval and range from 30 to 500 acres.

Typically, the surface layer of this soil is dark brown silty clay loam 11 inches thick. The upper part of the subsoil is reddish brown clay to a depth of 23 inches. The lower part of the subsoil is yellowish red clay to a depth of 48 inches and contains concretions and threads of calcium carbonate. This grades into a layer of yellowish red clay that contains cemented concretions, soft bodies, and threads of calcium carbonate to a depth of 63 inches. Reaction of the surface layer is mildly alkaline. Below a depth of 11 inches the soil is moderately alkaline.

This soil is well drained. Surface runoff is slow. Permeability is slow. The available water capacity is high. Natural fertility is high. The rooting zone is deep, and air, water, and roots move through the soil easily. This soil receives runoff from surrounding areas. There is a slight hazard of water erosion.

This soil is best tilled when soil moisture content is low. The natural structure is then broken but not

destroyed, and aeration is improved. Crop residue retained on the surface improves tilth and water intake.

Included with this soil in mapping are small, long, narrow areas of Boerne soils and small, slightly concave, somewhat circular areas of Oakalla soils. The included soils make up as much as 10 percent of each mapped area.

Areas of this Barbarosa soil are used mainly as cropland. Grain sorghum, oats, and wheat are the main crops. Improved bermudagrass is used for grazing and hay in places.

This soil is well suited to cultivated crops, rangeland, and improved pastureland. Crops respond well to fertilization.

This soil is poorly suited to most urban uses and to sanitary facilities, but it is moderately well suited to a few urban uses. Shrinking and swelling, slow permeability, and corrosivity to uncoated steel are the most limiting features. Septic tank absorption fields need to be enlarged or the design modified because the clayey lower layers of this soil reduce permeability.

The potential rangeland plant community is a tall grass prairie. Typically, the dominant plants are—

- little bluestem—50 percent
- indiangrass—10 percent
- big bluestem—10 percent
- mid grasses, such as sideoats grama, cane bluestem, vine-mesquite, Texas cupgrass, tall dropseed, and plains lovegrass—10 percent
- woody plants, such as elm, live oak, hackberry, bumelia, and elbowbush—10 percent
- forbs, such as Maximilian sunflower, Engelmann-daisy, and bushsunflower—10 percent

Total annual dry weight forage production per acre on this soil in excellent condition ranges from 6,500 pounds in favorable years to 4,000 pounds in unfavorable years.

Continuous heavy grazing by livestock decreases the proportion of preferred forage plants, such as little bluestem, indiangrass, and big bluestem. These are replaced by less desirable forage plants, such as sideoats grama, Texas wintergrass, cane bluestem, and buffalograss. Continued heavy grazing causes further loss of the better grasses and forbs and allows such plants as tumblegrass, hairy tridens, Texas grama, red threeawn, western ragweed, broomweed, prairie coneflower, mesquite, and Ashe juniper to dominate.

Areas of this soil provide fair habitat for deer, doves, and quail. The lack of adequate cover is a limiting factor for deer.

This Barbarosa soil is in capability class IIs and in the Clay Loam range site.

3—Boerne fine sandy loam. This deep, gently sloping soil is on flood plains or alluvial fans near streams. Slopes are mostly convex and average 1.5 percent. Mapped areas are long and narrow and range from 20 to 60 acres.

Typically, the surface layer is grayish brown fine sandy loam about 8 inches thick. The subsoil is pale brown loam to a depth of 46 inches. This grades into light yellowish brown loam that is stratified and has threads and soft to cemented bodies of calcium carbonate. Reaction of the soil is moderately alkaline throughout.

This soil is well drained. Surface runoff is slow. Permeability is moderately rapid. The available water capacity is medium. Natural fertility is medium. The root zone is deep, and air, water, and roots move through the soil easily. The hazard of water erosion is severe. Areas of this soil are flooded from once each year to once in 4 years.

Included with this soil in mapping are small, long, oval areas of Oakalla soils and long, narrow areas of Nuvalde soils. Also included is a stream channel, which is up to 100 feet wide in places. The included soils make up as much as 10 percent of each mapped area.

Areas of this Boerne soil are used as cropland and rangeland. Grain sorghum, oats, and wheat are the main crops.

This soil is moderately well suited to cultivated crops and improved bermudagrass. Low available water capacity is the most limiting feature. Keeping crop residue on the soil surface helps to control water erosion and conserve moisture. It also helps to improve soil tilth and water intake by preventing sealing of the surface layer. Contour farming and terracing help to control water erosion. Grassed waterways make good outlets for terrace systems if excess water is a problem. The high content of lime causes yellowing of the leaves, or iron chlorosis. In places, crusting of the surface layer prevents emergence of small seedlings.

Urban uses of this soil are limited by the flood hazard, seepage, and corrosivity to uncoated steel for underground pipe. This soil is moderately well suited to recreation uses. The hazard of flooding is a limitation.

The potential rangeland plant community is a grassed bottom land that has scattered trees. Typically, the dominant plants are—

- little bluestem, indiangrass, big bluestem, switchgrass, and eastern gamagrass—35 percent
- sideoats grama and cane bluestem—10 percent
- other mid grasses, such as Texas cupgrass, pinhole bluestem, meadow dropseed, vine-mesquite, tall dropseed, southwestern bristlegrass, Canada wildrye, purple tridens, broadleaf uniola, and buffalograss—35 percent
- woody plants, such as elm, live oak, wild grape, and greenbrier—15 percent
- forbs, such as Engelmann-daisy, bushsunflower, and Maximilian sunflower—5 percent

Total annual dry weight forage production per acre on this soil in excellent condition ranges from 5,500 pounds in favorable years to 3,000 pounds in unfavorable years.

Continuous heavy grazing by livestock decreases the proportion of preferred forage plants, such as little bluestem, big bluestem, eastern gamagrass, indiangrass, and Engelmann-daisy. These are replaced by less desirable forage plants, such as sideoats grama, pinhole

bluestem, and buffalograss. If heavy grazing continues for many years, oaks, elm, and mesquite form a dense stand with an understory of such plants as Texas wintergrass, common bermudagrass, and Ashe juniper.

Areas of this soil provide fair habitat for deer, turkeys, squirrels, and furbearing animals. Nesting areas for doves and songbirds are plentiful.

This Boerne soil is in capability subclass IIe and in the Loamy Bottomland range site.

4—Brackett association, undulating. This association consists of shallow, loamy soils on ridges and foot slopes. Slopes range from 1 to 8 percent. Mapped areas are long and oval or irregular in shape and range from 120 to 400 acres. The low, rounded hills have exposed bands or ledges of limestone that are perpendicular to the slopes. In places, angular and rounded limestone pebbles and cobbles are on the surface.

Brackett soils make up about 60 to 100 percent of each mapped area. The Brackett soils have a varying surface layer of gravelly loam, gravelly clay loam, loam, or clay loam. The rest of the association is small areas of Denton, Doss, Eckrant, and Krum soils. Denton and Krum soils are on lower parts of the landscape. Eckrant soils are on areas of hard limestone. Doss soils are on positions similar to those of the Brackett soils.

The mapped areas of this unit are large, and the composition is variable. Mapping has been controlled well enough, however, for the anticipated use of the areas.

Typically, the Brackett soils in this association have a surface layer of grayish brown clay loam about 8 inches thick. The subsoil is light brownish gray clay loam to a depth of 17 inches and has a few pebble-size fragments of limestone. The subsoil rests on a bed of marl and limestone. Reaction of the soil is moderately alkaline throughout (fig. 2).

These soils are well drained. Surface runoff is rapid. Permeability is moderately slow. The available water capacity is very low. Seeps are common after periods of high rainfall. Natural fertility is low. The root zone is shallow. The hazard of water erosion is severe.

Areas of these soils are used mainly as rangeland.

These soils are poorly suited to cultivated crops and improved pasture. Shallow depth, slope, high lime content, and low available water capacity are the most limiting features.

These soils are poorly suited to urban uses. Depth to rock and corrosivity to steel pipe are limitations. These soils are poorly suited to most recreation uses because of shallow depth to rock.

The potential rangeland plant community on the Brackett soils is a tall grass, live oak, Texas oak savannah. Typically, the dominant plants are—

- little bluestem—50 percent
- sideoats grama—10 percent
- indiangrass—5 percent
- other mid grasses, such as seep muhly, canyon muhly, pinhole bluestem, cane bluestem, tall dropseed, hairy grama, purple threeawn, and Wright threeawn—25 percent
- woody plants, such as Texas oak, agarito, evergreen sumac, flameleaf sumac, live oak, and greenbrier; and forbs, such as Engelmann-daisy, bushsunflower, and sensitivebrier—10 percent

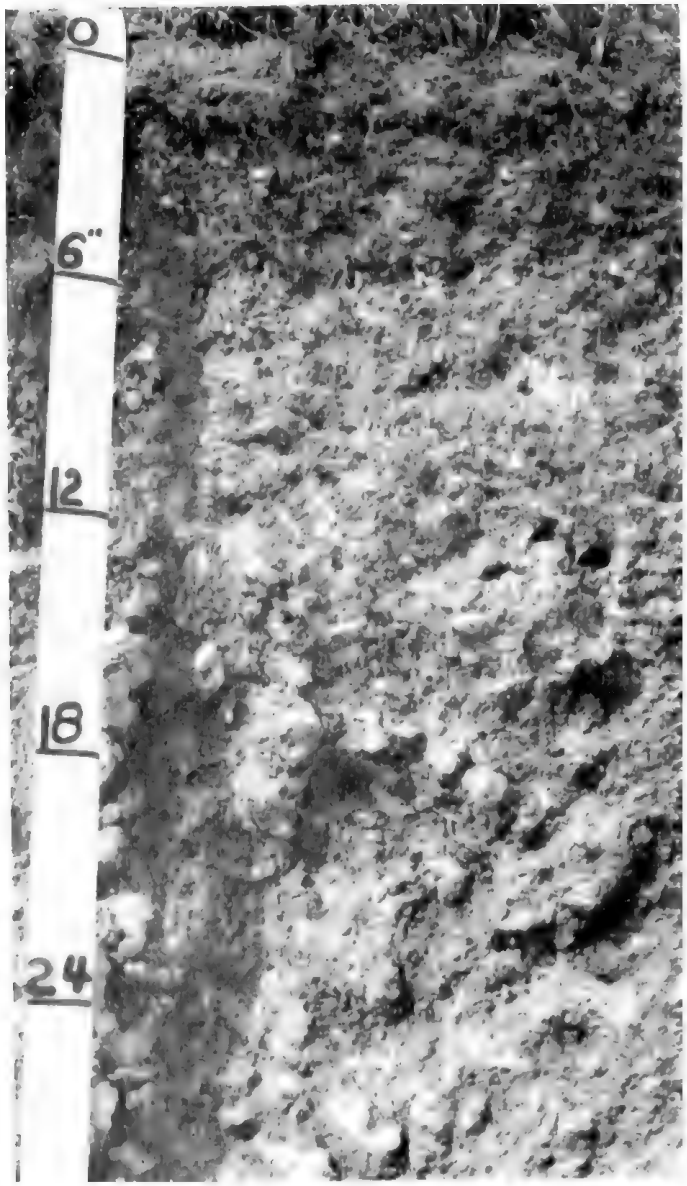

Figure 2.—Profile of Brackett clay loam. The parent material is weakly cemented limestone interbedded with marl. (The scale is in inches.)

Total annual dry weight forage production per acre on these soils in excellent condition ranges from 4,200 pounds in favorable years to 1,800 pounds in unfavorable years.

Continuous heavy grazing by livestock decreases the proportion of preferred forage plants, such as little bluestem, indiangrass, and Engelmann-daisy. These are replaced by less desirable forage plants, such as sideoats grama, tall grama, seep muhly, and live oak. If heavy grazing continues for many years, Ashe juniper invades and forms a dense stand with an understory of such plants as Texas grama, red grama, puffsheath dropseed, and Texas persimmon.

Areas of these soils provide fair habitat for deer, turkeys, and furbearing animals. Nesting areas for doves and songbirds are plentiful.

The soils in this Brackett association are in capability subclass VIs and in the Adobe range site.

5—Brackett-Real association, hilly. This association consists of shallow, gravelly and loamy soils. Slopes are convex and range from 8 to 30 percent. Mapped areas are oblong or irregular in shape and range from 150 to 1,500 acres. Horizontal limestone outcrops give the slopes a stairstepped, or benched, appearance. Angular limestone pebbles and cobbles are on the surface in some areas.

Brackett soils make up 65 percent of the association but range from 40 to 90 percent of each mapped area. Real soils make up 22 percent of the association but range from 20 to 60 percent of each mapped area. Brackett soils are between bands of Real soils. Real soils are in long, narrow, continuous bands that lie perpendicular to the slope. These bands range from 25 feet to 150 feet wide; width within a band is variable. The rest of the association is small areas of Doss, Eckrant, Krum, and Tarpley soils. Doss soils are on smoother slopes. Eckrant and Tarpley soils are on areas of hard limestone. Krum soils are on lower slopes.

These soils were not mapped separately because use and management are similar. The mapped areas of this unit are larger than most other mapped areas in the county, and the composition is variable. Mapping has been controlled well enough, however, for the anticipated use of the areas.

Typically, Brackett soils in this association have a surface layer of light brownish gray gravelly clay loam about 6 inches thick that contains a few soft bodies of calcium carbonate and about 15 percent limestone gravel. The subsoil is light brownish gray clay loam to a depth of 14 inches and has soft bodies of calcium carbonate. The subsoil rests on weakly cemented limestone interbedded with marl. Reaction of the soil is moderately alkaline throughout (see fig. 2).

Typically, Real soils in this association have a surface layer of dark grayish brown gravelly clay loam about 6 inches thick. The layer between 6 and 14 inches is dark grayish brown very gravelly clay loam that has about 40 percent angular, pebble-size fragments of limestone. This layer rests on weakly cemented limestone and marl. Reaction of the soil is moderately alkaline throughout (fig. 3).

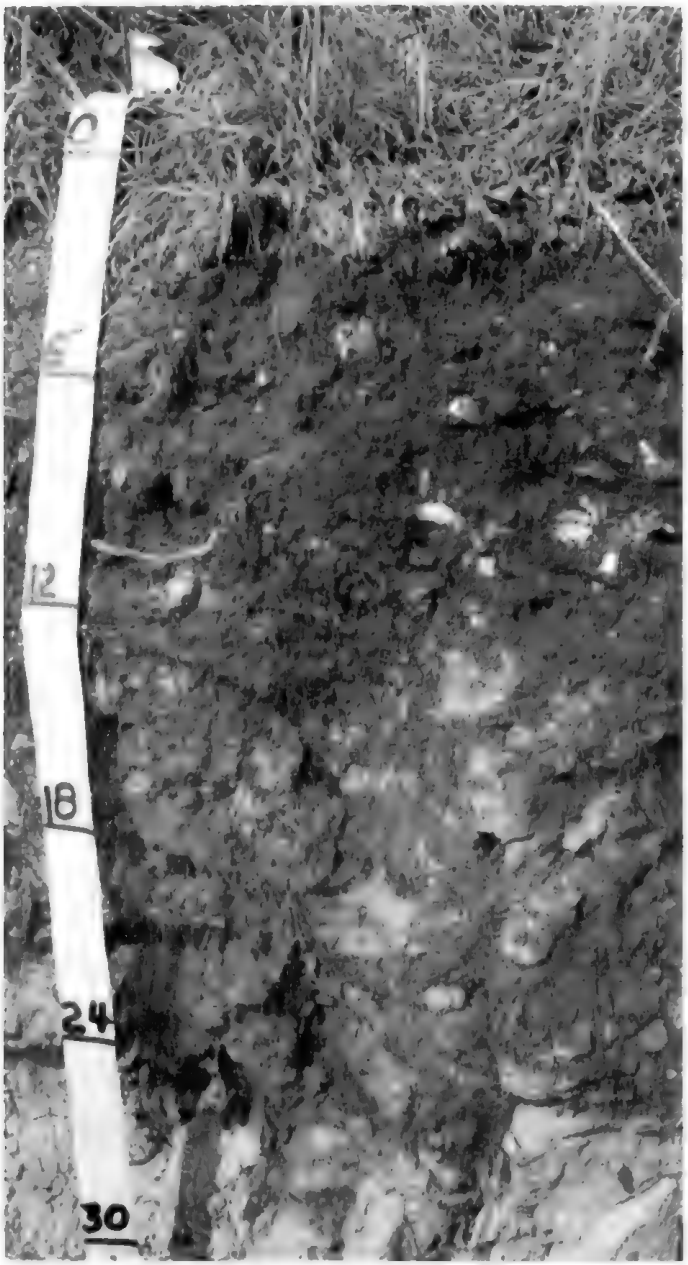

Figure 3.—Profile of Real gravelly clay loam. The underlying material of weakly cemented limestone and marl begins at a depth of about 14 inches.

The soils in this association are well drained. Surface runoff is rapid. Permeability is moderate to moderately slow. Seeps are common after periods of high rainfall. Natural fertility is low. The available water capacity is very low. The hazard of water erosion is severe.

Areas of this association are used mainly as rangeland.

The soils in this association are poorly suited to cropland and improved pastureland. Shallow rooting depth, strong to steep slope, high lime content, and very low available water capacity are the most limiting features.

The soils in this association are poorly suited to most urban and recreation uses. Slope, shallow depth to limestone, and corrosivity to uncoated steel are the most limiting features.

The potential rangeland plant community on the Brackett and Real soils is a Texas oak, live oak savannah. Typically, the dominant plants are—

- little bluestem—40 percent
- sideoats grama—10 percent
- mid grasses, such as tall grama, pinhole bluestem, tall dropseed, slim tridens, rough tridens, Wright threeawn, and seep muhly—25 percent
- woody plants, such as Texas oak, evergreen sumac, flameleaf sumac, live oak, and Ashe juniper—15 percent
- forbs, such as Englemann-daisy, bushsunflower, and sensitivebrier—10 percent

Total annual dry weight forage production per acre on these soils in excellent condition ranges from 3,000 pounds in favorable years to 1,500 pounds in unfavorable years.

Continuous heavy grazing by livestock decreases the proportion of preferred forage plants, such as little bluestem and Engelmann-daisy. These are replaced by less desirable forage plants, such as Wright threeawn, pinhole bluestem, canyon muhly, seep muhly, and Ashe juniper. If heavy grazing continues for many years, Ashe juniper increases to a dense stand and suppresses most other vegetation.

Livestock grazing is somewhat limited on a majority of the areas because of the steep and rough terrain. Thus, this site sometimes has greater value as wildlife habitat than for livestock production. Areas of this soil provide fair habitat for deer, turkeys, and furbearing animals. Nesting areas for doves and songbirds are plentiful.

The soils in this association are in capability subclass VIIs and in the Steep Adobe range site.

6—Denton silty clay, 1 to 3 percent slopes. This moderately deep, gently sloping soil is on uplands. Slopes are concave or convex. Mapped areas are long and oval or irregular in shape and range from 30 to 75 acres.

Typically, the surface layer is dark grayish brown silty clay 24 inches thick. The subsoil is brown clay to a depth of 39 inches and has small, rounded, soft calcium carbonate bodies and weakly cemented fragments of limestone. The subsoil rests on a bed of limestone and marl. Reaction of the soil is moderately alkaline throughout (fig. 4).

This soil is well drained. Surface runoff is medium. Permeability is slow. The available water capacity is medium. Natural fertility is medium. The root zone is moderately deep, although the high clay content of the soil impedes the movement of air and water and the penetration of roots. There is a slight hazard of water erosion.

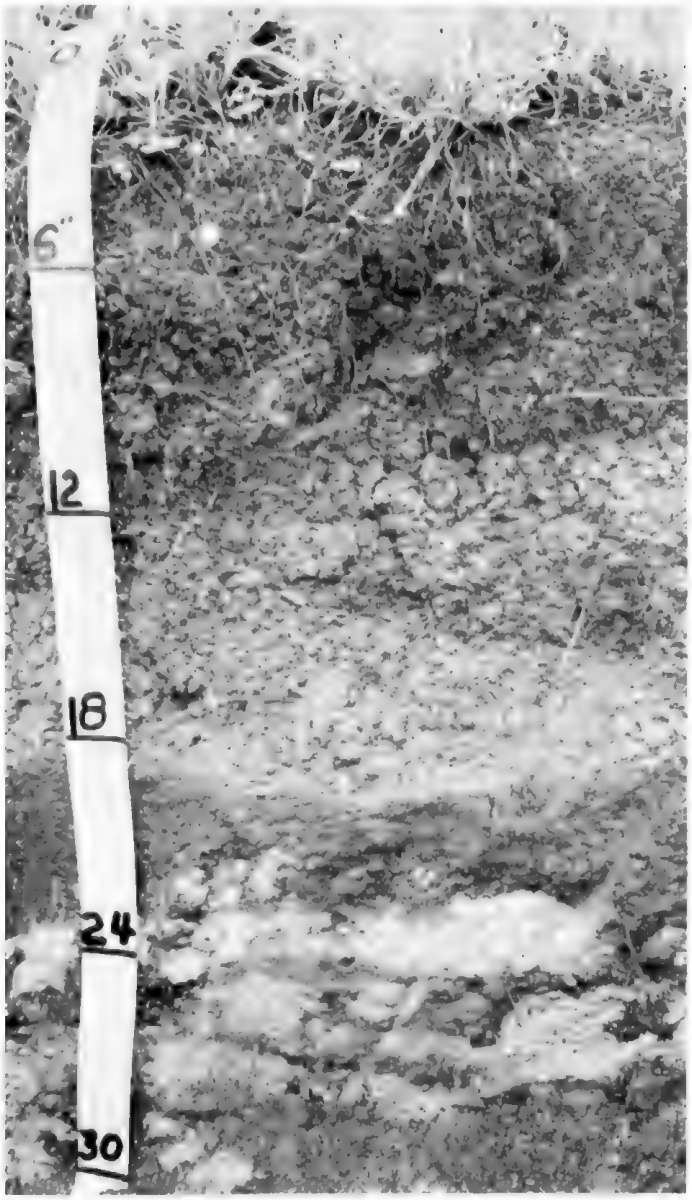

Figure 4.—Profile of Denton silty clay. Limestone and marl begins at a depth of about 24 inches.

Included with this soil in mapping are small, long, oval areas of Doss soils; small, long, narrow areas of Krum soils; and long, narrow areas of Nuvalde soils. The included soils make up 8 to 15 percent of each mapped area.

Areas of this Denton soil are used as cropland, rangeland, and improved pastureland.

This soil is moderately well suited to cultivated crops and improved pasture. The medium available water capacity is the most limiting feature. Grain sorghum, oats, and wheat are the principal crops. Crops respond well to fertilization, and nitrogen and phosphorus are needed to obtain optimum yields. This soil has good tilth if cultivated at a low soil moisture content. Terracing and contour farming help to control water erosion and conserve moisture. Crop residue left on the surface helps to maintain tilth and control erosion.

This soil is poorly suited to urban uses. The depth to rock, shrinking and swelling, and low strength are the main limitations. This soil is moderately well suited to recreation uses. The silty clay surface layer is the main limitation.

The potential rangeland plant community is a tall grass prairie. Typically, the dominant plants are—

- little bluestem—50 percent
- indiangrass—10 percent
- big bluestem—10 percent
- mid grasses, such as sideoats grama, cane bluestem, vine-mesquite, Texas cupgrass, tall dropseed, and plains lovegrass—20 percent
- woody plants, such as elm, live oak, hackberry, bumelia, and elbowbush; and forbs, such as Maximilian sunflower, Engelmann-daisy, and bushsunflower—10 percent

Total annual dry weight forage production per acre on this soil in excellent condition ranges from 6,500 pounds in favorable years to 4,000 pounds in unfavorable years.

Continuous heavy grazing by livestock decreases the proportion of preferred forage plants, such as little bluestem, indiangrass, and big bluestem. These are replaced by less desirable forage plants, such as sideoats grama, Texas wintergrass, cane bluestem, and buffalograss. Continued heavy use causes further deterioration and allows such plants as tumblegrass, hairy tridens, Texas grama, red threeawn, western ragweed, broomweed, prairie coneflower, mesquite, and Ashe juniper to dominate.

Areas of this soil provide fair habitat for deer, doves, and quail. The lack of adequate cover is a limiting factor for deer.

This Denton soil is in capability subclass IIe and in the Clay Loam range site.

7—Denton silty clay, 3 to 5 percent slopes. This moderately deep, gently sloping soil is on the sides of hills and ridges and on uplands. Slopes are slightly concave. Mapped areas are irregular in shape or long and oval and range from 25 to 125 acres.

Typically, the surface layer is dark grayish brown silty clay about 8 inches thick. The next layer is brown silty clay to a depth of 30 inches. The subsoil is brown clay to a depth of 34 inches and contains soft and cemented bodies of calcium carbonate. The subsoil rests on a bed of strongly cemented limestone. Reaction of the soil is moderately alkaline throughout.

This soil is well drained. Surface runoff is rapid. Permeability is slow. The available water capacity is medium. Natural fertility is medium. The root zone is moderately deep, although the high clay content of the soil impedes the movement of air and water and the penetration of roots. The hazard of water erosion is moderate.

Included with this soil in mapping are small, narrow areas of Brackett soils and small, circular or long, oval areas of Doss soils. The included soils make up 5 to 15 percent of each mapped area.

Areas of this Denton soil are used for cropland, rangeland, and pastureland.

This soil is moderately well suited to cropland and improved pastureland. Grain sorghum, oats, wheat, and improved bermudagrass are the principal crops. The medium available water capacity is the most limiting feature. This soil has good tilth if cultivated at a low soil moisture content. Terracing and contour farming help to control water erosion and conserve moisture. Crop residue left on the surface helps to maintain tilth and control erosion. Crops respond well to fertilization, and nitrogen and phosphorus are needed to maintain yields.

This soil is poorly suited to most urban uses. The shallow depth to rock, low strength, shrinking and swelling, and slope are the main limitations. This soil is moderately well suited to recreation uses. The silty clay surface layer is the main limitation.

The potential rangeland plant community is a tall grass prairie. Typically, the dominant plants are—

- little bluestem—50 percent
- indiangrass—10 percent
- big bluestem—10 percent
- mid grasses, such as sideoats grama, cane bluestem, vine-mesquite, Texas cupgrass, tall dropseed, and plains lovegrass—20 percent
- woody plants, such as elm, live oak, hackberry, bumelia, and elbowbush; and forbs, such as Maximilian sunflower, Engelmann-daisy, and bushsunflower—10 percent

Total annual dry weight forage production per acre on this soil in excellent condition ranges from 6,500 pounds in favorable years to 4,000 pounds in unfavorable years.

Continuous heavy grazing by livestock decreases the proportion of preferred forage plants, such as little bluestem, indiangrass, and big bluestem. These are replaced by less desirable forage plants, such as sideoats grama, Texas wintergrass, cane bluestem, and buffalograss. Continued heavy use causes further deterioration and allows such plants as tumblegrass, hairy tridens, Texas grama, red threeawn, western

ragweed, broomweed, prairie coneflower, mesquite, and Ashe juniper to dominate.

Areas of this soil provide fair habitat for deer, doves, and quail. The lack of adequate cover is a limiting factor for deer.

This Denton soil is in capability subclass IIIe and in the Clay Loam range site.

8—Doss silty clay, 1 to 5 percent slopes. This shallow, gently sloping soil is on uplands. It is underlain by cemented marl and caliche. Slopes are smooth and average 3.5 percent. Mapped areas are oblong and range from 20 to 140 acres.

Typically, the surface layer is dark grayish brown silty clay about 9 inches thick. The subsoil is brown silty clay to a depth of 18 inches and contains many soft bodies of calcium carbonate. This rests on a bed of cemented marl and caliche that becomes softer as depth increases. Reaction of the soil is moderately alkaline throughout (fig. 5).

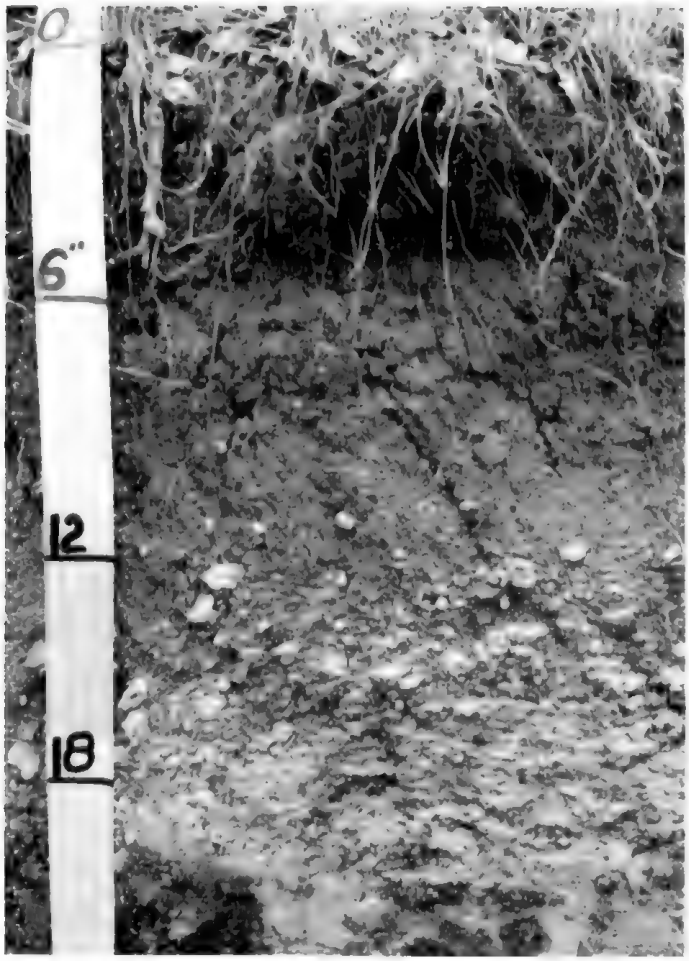

Figure 5.—Profile of Doss silty clay. This shallow soil overlies cemented caliche. (The scale is in inches.)

This soil is well drained. Surface runoff is medium. Permeability is moderately slow. The available water capacity is low. Natural fertility is moderately low. The root zone is shallow. The hazard of water erosion is moderate.

Included with this soil in mapping are small, roughly circular areas that have a clay loam surface layer with less than 35 percent clay and a few small, long, oval areas of Brackett and Denton soils. The included soils make up 5 to 15 percent of each mapped area.

Areas of this Doss soil are used as cropland and rangeland.

This soil is moderately well suited to cropland and pastureland. Shallow rooting depth and low available water capacity are the most limiting features. Grain sorghum, oats, and wheat are the main crops. Crops respond to fertilization. Nitrogen and phosphorus are needed to maintain yields. The moderate hazard of erosion limits use of this soil for cultivated crops. Crop residue kept on the surface helps to maintain good tilth, conserve moisture, and control erosion. Contour farming and terracing are needed to control water erosion. Where cuts or excavations for terraces or waterways exceed a depth of about 13 inches, there is a hazard of cutting into cemented caliche. The high content of lime causes iron chlorosis in some crops.

This soil is poorly suited to most urban uses. The clayey texture, shallow depth to rock, low strength, shrinking and swelling, corrosivity to uncoated steel, and moderately slow permeability are the most limiting features. This soil is poorly suited to recreation uses. The shallow depth to rock is the main limitation.

The potential rangeland plant community is an open grassland that has scattered mottes of oak. Typically, the dominant plants are—

- little bluestem—25 percent
- sideoats grama—30 percent
- other mid grasses, such as Texas cupgrass, pinhole bluestem, Texas wintergrass, vine-mesquite, curlymesquite, and buffalograss—35 percent
- woody plants, such as shinnery oak, live oak, and hackberry—5 percent
- forbs, such as Engelmann-daisy, bushsunflower, and sensitivebrier—5 percent

Total annual dry weight forage production per acre from this soil in excellent condition ranges from 3,000 pounds in favorable years to 1,800 pounds in unfavorable years.

Continuous heavy grazing by livestock decreases the proportion of preferred forage plants, such as little bluestem and Engelmann-daisy. These are replaced by less desirable forage plants, such as sideoats grama, pinhole bluestem, buffalograss, and post oak. If heavy grazing continues for many years, oaks and juniper form a dense stand with an understory of such plants as threeawn, hairy tridens, Texas grama, red grama, pricklypear, and mesquite.

Areas of this soil provide fair habitat for deer, turkeys, and furbearing animals. Nesting areas for doves and songbirds are plentiful.

This Doss soil is in capability subclass IIIe and in the Shallow range site.

9—Doss-Brackett association, undulating. This association consists of shallow, loamy and clayey soils on uplands. Slopes are convex and range from 1 to 8 percent. Mapped areas are irregular to oval in shape and range from 50 to 600 acres (fig. 6).

Doss soils are in all mapped areas and make up 48 percent of the association. Brackett soils are in all mapped areas and make up 28 percent of the association. Eckrant, Krum, and Tarpley soils make up about 24 percent. Eckrant and Tarpley soils are underlain by hard limestone. Krum soils are on lower parts of the landscape.

The composition of this association is variable. However, use and management of the soils are similar, and mapping has been controlled well enough for the anticipated use of the areas.

Doss soils are on the less sloping parts of this association in long, narrow, concentric bands that follow the slope contour. Typically, the surface layer is dark grayish brown silty clay 11 inches thick. The next layer is brown silty clay to a depth of 18 inches. The underlying material is white, soft, chalky earth. Reaction of the soil is moderately alkaline throughout.

Brackett soils are on crescent-shaped or oval knolls. Typically, the surface layer is light brownish gray clay loam 7 inches thick. The subsoil is very pale brown clay loam to a depth of 19 inches and contains about 20 percent by volume soft and weakly cemented bodies of calcium carbonate. The subsoil rests on thinly interbedded, weakly cemented limestone and marl. Reaction of the soil is moderately alkaline throughout.

The soils in this association are well drained. Surface runoff is medium to rapid. Permeability is moderately slow. The available water capacity is low to very low. Seeps are common after periods of high rainfall. Natural fertility is moderately low. The root zone is shallow. The hazard of water erosion is severe. The high content of lime causes iron chlorosis in some plants.

Areas of this association are used as rangeland.

The Brackett soils in this association are poorly suited to cultivated crops and improved pasture. The Doss soils are suited to cultivated crops and improved pasture. Shallow rooting depth, slope, high content of lime, low available water capacity, and rock ledges are the most limiting features.

The soils in this association are poorly suited to most urban and recreation uses. Shallow depth to rock limits

Figure 6.—An area of Doss-Brackett association, undulating. Areas of this association are used as rangeland.

recreation use. Shallow depth to rock and corrosivity to steel pipe are limitations for urban use.

The potential rangeland plant community on the Doss soils is an open grassland that has scattered mottes of oak. Typically, the predominant plants are—

- little bluestem—25 percent
- sideoats grama—30 percent
- other mid grasses, such as Texas cupgrass, pinhole bluestem, Texas wintergrass, vine-mesquite, curlymesquite, and buffalograss—35 percent
- woody plants, such as shin oak, live oak, and hackberry—5 percent
- forbs, such as Engelmann-daisy, bushsunflower, and sensitivebrier—5 percent

Total annual dry weight forage production per acre on the Doss soils in excellent condition ranges from 3,000 pounds in favorable years to 1,800 pounds in unfavorable years.

Continuous heavy grazing by livestock decreases the proportion of preferred forage plants, such as little bluestem and Engelmann-daisy. These are replaced by less desirable forage plants, such as sideoats grama, pinhole bluestem, buffalograss, and post oak. If heavy grazing continues for many years, oaks and juniper form a dense stand with an understory of such plants as threeawn, hairy tridens, Texas grama, red grama, pricklypear, and mesquite.

The potential rangeland plant community on the Brackett soils is a tall grass, live oak, Texas oak savannah. Typically, the dominant plants are—

- little bluestem—50 percent
- sideoats grama—10 percent
- indiangrass—5 percent
- other mid grasses, such as seep muhly, canyon muhly, pinhole bluestem, cane bluestem, tall dropseed, hairy grama, purple threeawn, and Wright threeawn—25 percent
- woody plants, such as Texas oak, agarito, evergreen sumac, flameleaf sumac, live oak, and greenbrier; and forbs, such as Engelmann-daisy, bushsunflower, and sensitivebrier—10 percent

Total annual dry weight forage production per acre on the Brackett soils in excellent condition ranges from 4,200 pounds in favorable years to 1,800 pounds in unfavorable years.

Continuous heavy grazing by livestock decreases the proportion of preferred forage plants, such as little bluestem, indiangrass, and Engelmann-daisy. These are replaced by less desirable forage plants, such as sideoats grama, tall grama, seep muhly, and live oak. If heavy grazing continues for many years, Ashe juniper invades and forms a dense stand with an understory of such plants as Texas grama, red grama, puffsheath dropseed, and Texas persimmon.

Areas of these soils provide habitat for deer, turkeys, and furbearing animals. Nesting areas for doves and songbirds are plentiful.

The Doss soils are in capability subclass VIe and in the Shallow range site. The Brackett soils are in capability subclass VIs and in the Adobe range site.

10—Eckrant-Comfort association, gently undulating. This association consists of shallow, cobbly and stony soils on broad upland hilltops. Slopes are plane to convex and range from 1 to 5 percent. Mapped areas are irregular in shape and range from 300 to more than 1,000 acres.

Eckrant soils are in all mapped areas in an irregular pattern. They make up 50 to 90 percent of each mapped area and average about 66 percent. Comfort soils average about 17 percent. The rest of the association is Rock outcrop and small areas of Tarpley soils.

The areas of this map unit are much larger than those of other map units in the county, and the composition is more variable. However, mapping has been controlled well enough for the anticipated use of the areas.

Typically, the Eckrant soils have a surface layer of very dark gray, mildly alkaline stony clay 5 inches thick. This rests abruptly on fractured limestone bedrock (fig. 7).

Typically, the Comfort soils have a surface layer of dark grayish brown stony clay 5 inches thick. The subsoil is dark reddish gray stony clay to a depth of 17 inches. This rests abruptly on indurated, crystalline, dolomitic limestone bedrock. Reaction of the soil is mildly alkaline throughout (fig. 8).

These soils are well drained. Surface runoff is slow to rapid. Permeability is slow or moderately slow. The

Figure 7.—Profile of Eckrant soil. This stony soil rests on indurated limestone bedrock. (The scale is in inches.)

Figure 8.—Profile of Comfort soil over indurated limestone. (The scale is in inches.)

available water capacity is very low. Natural fertility is medium. The root zone is shallow. The hazard of water erosion is severe.

The soils in this association are poorly suited to cultivated crops and improved pasture. The cobbly and stony clay surface layer, shallow rooting depth, slope, and very low available water capacity are the most limiting features.

The soils in this association are poorly suited to most urban and recreation uses. Slope, the cobbly and stony clay surface layer, rockiness, shallow depth to limestone bedrock, and corrosivity to uncoated steel are the most limiting features.

The potential rangeland plant community is a tall grass, live oak savannah. Typically, the dominant plants are—

- little bluestem—50 percent
- indiangrass and big bluestem—20 percent
- sideoats grama and other mid grasses, such as Texas cupgrass, cane bluestem, plains lovegrass, vine-mesquite, tall dropseed, and buffalograss—20 percent
- woody plants, such as live oak, elm, hackberry, and greenbrier; and forbs, such as Engelmann-daisy, bushsunflower, and sensitivebrier—10 percent

Total annual dry weight forage production per acre on these soils in excellent condition ranges from 6,000 pounds in favorable years to 3,000 pounds in unfavorable years.

Continuous heavy grazing by livestock decreases the proportion of preferred forage plants, such as little bluestem, indiangrass, and Engelmann-daisy. These are replaced by less desirable forage plants, such as sideoats grama, pinhole bluestem, buffalograss, live oak, and Ashe juniper. If heavy grazing continues for many years, Ashe juniper forms a stand with an understory of such plants as threeawn, Texas wintergrass, buffalograss, Texas persimmon, and agarito.

Areas of this soil provide fair habitat for deer, turkeys, squirrels, and furbearing animals. Nesting areas for doves and songbirds are plentiful.

The Eckrant soils are in capability subclass VIIs, and the Comfort soils are in capability subclass VIs. Both soils are in the Low Stony Hill range site.

11—Eckrant-Rock outcrop association, steep. This association consists of Rock outcrop and very shallow, cobbly and stony, clayey soils. It is on the sides of long, narrow limestone hills which are the side slopes of some of the secondary drainageways in the county. Slopes are convex and range from 8 to 30 percent. Mapped areas are long and narrow and generally follow the contour of the hillsides. Areas range from 80 to 240 acres.

Eckrant soils average 70 percent of the association but range from 60 to 90 percent of each mapped area. Rock outcrop averages 26 percent of the association and ranges from 10 to 30 percent of each mapped area. The Rock outcrop occurs as ledges that follow the slope contour.

The mapped areas of this unit are large, and the composition is variable. However, mapping has been controlled well enough for the anticipated use of the areas (fig. 9).

Typically, Eckrant soils have a surface layer of very dark gray stony clay 8 inches thick that contains 60 percent by volume cobble- and stone-size fragments of limestone. The layer from 8 to 14 inches is brown stony clay that contains 60 percent by volume cobble-size fragments and 20 percent by volume stone-size fragments of limestone. This layer rests abruptly on indurated, fractured limestone bedrock. Cobbles and stones cover up to 70 percent of the surface of the soil. Reaction of the soil is moderately alkaline throughout.

The Eckrant soils are well drained. Surface runoff is rapid. Permeability is moderately slow. The available water capacity is very low. Natural fertility is medium. The root zone is shallow. The hazard of water erosion is severe.

Rock outcrops extend as much as 8 inches above the soil surface and are 10 to 20 feet wide. In some areas mapped as outcrop, there may be as much as 3 inches of soil. The layered bedrock is up to 50 feet thick. Fractured fragments of bedrock range from 6 inches to more than 20 feet thick.

The soils in this association are poorly suited to cropland and improved pastureland. The stony clay surface layer, large stones, rock outcrops, shallow rooting depth, slope, and very low available water capacity are the most limiting features.

The soils in this association are poorly suited to most urban and recreation uses. Slope, the stony clay surface layer, shallow depth to limestone bedrock, large stones,

Figure 9.—An area of Eckrant-Rock outcrop association, steep. The ledges of limestone, which are 10 to 20 feet wide, follow the contour of the slope.

and corrosivity to uncoated steel are the most limiting features.

The potential rangeland plant community on the Eckrant soils is a live oak, Texas oak savannah. Typically, the dominant plants are—

- little bluestem—35 percent
- sideoats grama—15 percent
- indiangrass—5 percent
- other mid grasses, such as Texas cupgrass, cane bluestem, pinhole bluestem, tall grama, purple threeawn, plains lovegrass, and green sprangletop—35 percent
- woody plants, such as Texas oak, live oak, and greenbrier; and forbs, such as Engelmann-daisy, bushsunflower, and bundleflower—10 percent

Total annual dry weight forage production per acre on this soil in excellent condition ranges from 1,700 pounds in favorable years to 1,000 pounds in unfavorable years.

Continuous heavy grazing by livestock decreases the proportion of preferred forage plants, such as little bluestem, indiangrass, and Engelmann-daisy. These are replaced by less desirable forage plants such as sideoats grama, pinhole bluestem, and live oak. If heavy grazing continues for many years, oaks form a dense stand with an understory of such plants as threeawn, Texas wintergrass, slim tridens, Ashe juniper, and Texas persimmon.

Areas of this association provide fair habitat for a variety of wildlife, such as deer, doves, and quail. Turkeys and squirrels from adjacent bottom lands come to the areas and feed extensively on acorn and other mast. Many songbirds and small mammals inhabit the areas. Because of the slope and rocky nature of the soil, wildlife habitat is the main land use in places.

The Eckrant soils are in capability subclass VIIs and in the Steep Rocky range site. Rock outcrop is not assigned to a capability subclass or range site.

12—Krum silty clay, 1 to 3 percent slopes. This deep, gently sloping soil is at the base of limestone hills. Slopes are smooth to concave. Mapped areas are long and narrow and range from 20 to 80 acres. Most areas are dissected by a U-shaped, intermittent, spring-fed drainage channel that is 2 to 8 feet deep and 4 to 12 feet wide.

Typically, the surface layer of this soil is dark grayish brown silty clay 21 inches thick. The subsoil is grayish brown silty clay to a depth of 40 inches. The layer from 40 to 62 inches is silty clay that contains soft bodies of calcium carbonate and small fragments of limestone. It is pale brown in the upper part and light yellowish brown in the lower part. Reaction of the soil is moderately alkaline throughout (fig. 10).

This soil is well drained. Surface runoff is slow. Permeability is moderately slow. The available water capacity is high. Natural fertility is medium. The root zone is deep, although the high clay content of the soil impedes the movement of air and water and the penetration of roots. The hazard of water erosion is moderate.

Included with this soil in mapping are small, long, oval areas of Denton and Doss soils and soils that are wet

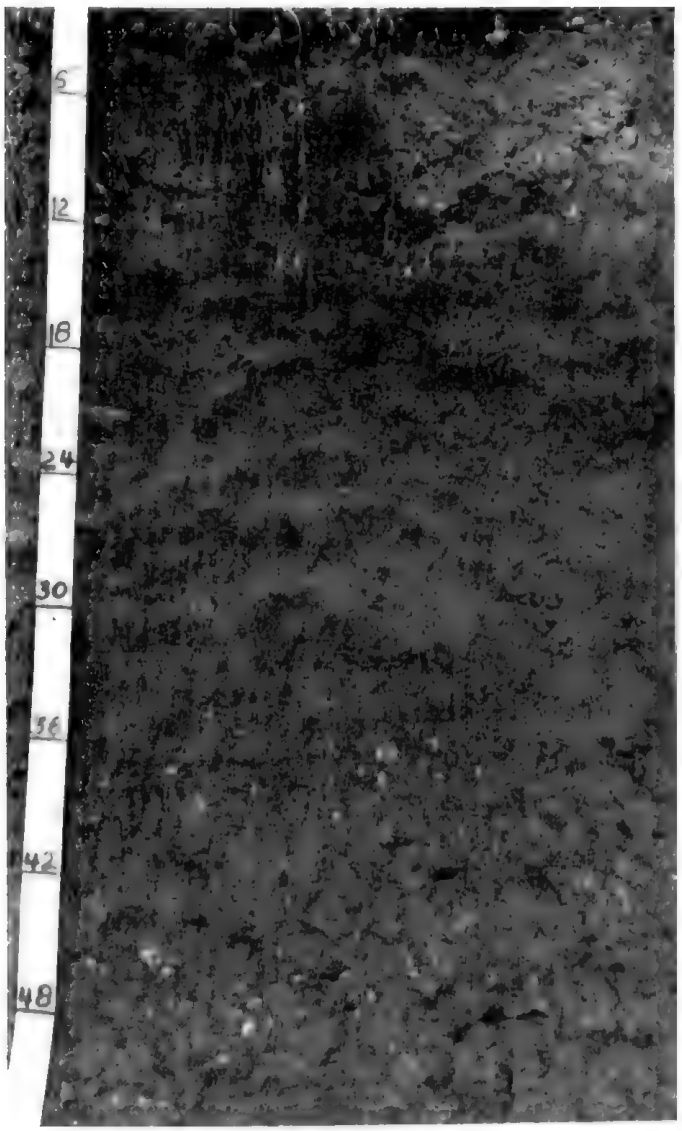

Figure 10.—Profile of Krum silty clay. This soil is in narrow valleys between hills of Brackett soils. (The scale is in inches.)

most of the year. The included soils make up as much as 15 percent of each mapped area.

This soil is used as cropland and rangeland. Grain sorghum, oats, wheat, tame pasture, and grass for hay are the main crops.

This Krum soil is well suited to cultivated crops and improved pasture. Keeping crop residue on the surface helps to control water erosion, conserve moisture, and improve soil tilth and water intake. Tilling when moisture content of the soil is low helps to maintain good soil structure and aeration. Contour farming and terracing are needed in most areas to control water erosion. Grassed waterways make good outlets for terrace systems if excess water is a problem. Crops respond well to fertilization, and nitrogen and phosphorus are needed to maintain good yields.

This soil is poorly suited to most urban uses. Shrinking and swelling, low strength, cutbanks caving, and high corrosivity to uncoated steel are limiting features. Most of these limitations can be overcome by proper design and careful installation. The clayey lower layer of this soil restricts permeability. This limits the use of this soil for septic tank absorption fields. The absorption area must be enlarged or the design modified. This soil is poorly suited to recreation uses. The clayey surface layer and moderately slow permeability are the most limiting features.

The potential rangeland plant community is a tall grass, live oak savannah. Typically, the dominant plants are—

- little bluestem—50 percent
- indiangrass—10 percent
- big bluestem—10 percent
- other mid grasses, such as sideoats grama, Texas cupgrass, cane bluestem, meadow dropseed, Texas wintergrass, vine-mesquite, tall dropseed, and plains lovegrass—20 percent
- woody plants, such as elm, live oak, hackberry, bumelia, and elbowbush; and forbs, such as Engelmann-daisy, bushsunflower, and Maximilian sunflower—10 percent

Total annual dry weight forage production per acre on this soil in excellent condition ranges from 6,500 pounds in favorable years to 4,000 pounds in unfavorable years.

Continuous heavy grazing by livestock decreases the proportion of preferred forage plants, such as little bluestem, indiangrass, and Engelmann-daisy. These are replaced by less desirable forage plants, such as sideoats grama, Texas wintergrass, and buffalograss. If heavy grazing continues for many years, such plants as threeawn, Texas wintergrass, Ashe juniper, Texas persimmon, pricklypear, and mesquite dominate.

Areas of this soil provide fair habitat for deer, doves, and quail. The lack of adequate cover is a limiting factor for deer.

This Krum soil is in capability subclass IIe and in the Clay Loam range site.

13—Krum silty clay, 3 to 5 percent slopes. This deep, gently sloping soil is on foot slopes of limestone hills. Slopes are concave. Mapped areas are long and narrow, and range from 40 to 120 acres. Most areas contain U-shaped, intermittent, spring-fed drainage channels that are 2 to 12 feet deep and 10 to 60 feet wide.

Typically, the surface layer of this soil is dark grayish brown silty clay 16 inches thick. The next layer is brown silty clay to a depth of 42 inches. The subsoil is light yellowish brown silty clay to a depth of 60 inches and contains films, threads, soft bodies, and concretions of calcium carbonate. This layer also contains small fragments of limestone. Reaction of the soil is moderately alkaline throughout.

This soil is well drained. Surface runoff is medium. Permeability is moderately slow. The available water capacity is high. Natural fertility is medium. The root zone is deep, although the clay content of the soil impedes the movement of air and water and the penetration of roots. The hazard of water erosion is moderate.

Included with this soil in mapping are small, long, oval areas of Denton and Doss soils; small circular knolls of Brackett soils; and small, long, narrow areas that are wet most of the year. The included areas make up as much as 15 percent of each mapped area.

Areas of this soil are used as cropland and rangeland. Grain sorghum, oats, wheat, tame pasture, and grass for hay are the main crops.

This Krum soil is well suited to cultivated crops and improved pasture. Keeping crop residue on the soil surface helps to control water erosion, conserve moisture, and improve soil tilth and water intake. Tilling when the moisture content of the soil is low helps to maintain good soil structure and aeration. Contour farming and terracing are needed in most areas to control water erosion. Grassed waterways are good outlets for terrace systems if excess water is a problem. Crops respond well to fertilization. Nitrogen and phosphorus are needed to maintain good yields.

This soil is poorly suited to most urban and recreation uses. Shrinking and swelling, cutbanks caving, and high corrosivity to uncoated steel are limiting features. Most of these limitations can be overcome by proper design and careful installation. The clayey lower layer of this soil restricts permeability. This limits the use of this soil for septic tank absorption fields. The absorption area needs to be enlarged or the design modified.

The potential rangeland plant community is a tall grass, live oak savannah. Typically, the dominant plants are—

- little bluestem—50 percent
- indiangrass—10 percent
- big bluestem—10 percent
- other mid grasses, such as sideoats grama, Texas cupgrass, cane bluestem, meadow dropseed, Texas wintergrass, vine-mesquite, tall dropseed, and plains lovegrass—20 percent
- woody plants, such as elm, live oak, hackberry, bumelia, and elbowbush; and forbs, such as Engelmann-daisy, bushsunflower, and Maximilian sunflower—10 percent

Total annual dry weight forage production per acre on this soil in excellent condition ranges from 6,500 pounds in favorable years to 4,000 pounds in unfavorable years.

Continuous heavy grazing by livestock decreases the proportion of preferred forage plants, such as little bluestem, indiangrass, and Engelmann-daisy. These are replaced by less desirable forage plants, such as sideoats grama, Texas wintergrass, and buffalograss. If heavy grazing continues for many years, such plants as threeawn, Texas wintergrass, Ashe juniper, Texas persimmon, pricklypear, and mesquite dominate.

Areas of this soil provide fair habitat for deer, doves, and quail. The lack of adequate cover is a limiting factor for deer.

This Krum soil is in capability subclass IIIe and in the Clay Loam range site.

14—Nuvalde silty clay, 0 to 1 percent slopes. This deep, nearly level soil is on terraces near flood plains of streams. Slopes are smooth or slightly concave. Mapped areas are long-oval or long-narrow and range from 25 to 50 acres.

Typically, the surface layer of this soil is dark brown silty clay 12 inches thick. The subsoil is silty clay. From 12 to 20 inches it is dark brown and has concretions and threads of calcium carbonate. From 20 to 30 inches it is reddish brown and has many soft bodies, concretions, and threads of calcium carbonate. The layer from 30 to 60 inches is yellowish red silty clay in the upper part and clay loam in the lower part and contains soft bodies, threads, and films of calcium carbonate. Reaction of the soil is moderately alkaline throughout.

This soil is well drained. Surface runoff is slow. Permeability is moderate. The available water capacity is high. Natural fertility is high. The hazard of water erosion is slight.

Tilling when the moisture content of the soil is low improves aeration of the soil and prevents the formation of large clods. The root zone is deep, and air, water, and roots move through the soil easily. This soil receives runoff from surrounding areas.

Included with this soil in mapping are small areas of Boerne, Oakalla, and Doss soils. The included areas make up as much as 10 percent of each mapped area.

This Nuvalde soil is used as cropland, pastureland, and rangeland. Grain sorghum, oats, wheat, and bermudagrass for hay and grazing are the main crops.

This soil is well suited to crops and improved pasture. Retaining crop residue on the surface helps to control water erosion, conserve moisture, improve tilth, and increase water intake. Crops respond to fertilization.

This soil is moderately well suited to most urban uses, but it is poorly suited to a few urban uses. Shrinking and swelling and corrosivity to uncoated steel are the most limiting features. This soil is moderately well suited to recreation uses. The silty clay surface layer is the most limiting feature.

The potential rangeland plant community is a tall grass, live oak savannah. Typically, the dominant plants are—

- little bluestem—50 percent
- indiangrass—10 percent
- big bluestem—10 percent
- mid grasses, such as sideoats grama, Texas cupgrass, cane bluestem, meadow dropseed, Texas wintergrass, vine-mesquite, tall dropseed, and plains lovegrass—20 percent
- woody plants, such as elm, live oak, hackberry, bumelia, and elbowbush; and forbs, such as

Engelmann-daisy, bushsunflower, and Maximilian sunflower—10 percent

Total annual dry weight forage production per acre on this soil in excellent condition ranges from 6,500 pounds in favorable years to 4,000 pounds in unfavorable years.

Continuous heavy grazing by livestock decreases the proportion of preferred forage plants, such as little bluestem, indiangrass, and Engelmann-daisy. These are replaced by less desirable forage plants, such as sideoats grama, Texas wintergrass, and buffalograss. If heavy grazing continues for many years, plants such as threeawn, Texas wintergrass, Ashe juniper, Texas persimmon, pricklypear, and mesquite dominate.

Areas of this soil provide fair habitat for deer, doves, and quail. The lack of adequate cover is a limiting factor for deer.

This Nuvalde soil is in capability subclass IIc and in the Clay Loam range site.

15—Nuvalde silty clay, 1 to 3 percent slopes. This deep, gently sloping soil is on terraces and foot slopes near the flood plains of streams. Slopes are slightly concave. Mapped areas are long and oval and range from 25 to 80 acres.

Typically, the surface layer of this soil is dark brown silty clay 11 inches thick. The subsoil is reddish brown silty clay to a depth of 37 inches and contains soft and cemented bodies of calcium carbonate. The layer from 37 to 44 inches is reddish brown silty clay that contains threads, films, and soft and cemented bodies of calcium carbonate. The next layer is yellowish red clay loam to a depth of 63 inches. Reaction of the soil is moderately alkaline throughout.

This soil is well drained. Surface runoff is medium. Permeability is moderate. The available water capacity is high. Natural fertility is high. The hazard of water erosion is moderate.

Tilling when the moisture content of the soil is low improves aeration of the soil and prevents the formation of large clods. The root zone is deep, and air, water, and roots move through the soil easily. Areas of this soil receive runoff from surrounding areas. Crops respond to fertilization.

Included with this soil in mapping are small, oblong areas of soils that are similar to the Nuvalde soil but have a light colored surface layer. Also included are roughly circular areas of Doss and Denton soils. The included areas make up as much as 10 to 15 percent of each mapped area.

This Nuvalde soil is used as cropland, pastureland, and rangeland. Grain sorghum, oats, wheat, and bermudagrass for hay and grazing are the main crops.

This soil is well suited to cropland and tame pastureland. Keeping crop residue on the soil surface helps to control water erosion, conserve moisture, improve soil tilth, and increase water intake.

This soil is moderately well suited to most urban uses, but poorly suited to a few urban uses. Shrinking and swelling and corrosivity to uncoated steel are the most limiting features. This soil is moderately well suited to recreational uses. The clayey surface layer is the most limiting feature.

The potential rangeland plant community is a tall grass, live oak savannah. Typically, the dominant plants are—

- little bluestem—50 percent
- indiangrass—10 percent
- big bluestem—10 percent
- mid grasses, such as sideoats grama, Texas cupgrass, cane bluestem, meadow dropseed, Texas wintergrass, vine-mesquite, tall dropseed, and plains lovegrass—20 percent
- woody plants, such as elm, live oak, hackberry, bumelia, and elbowbush; and forbs, such as Engelmann-daisy, bushsunflower, and Maximilian sunflower—10 percent

Total annual dry weight forage production per acre on this soil in excellent condition ranges from 6,500 pounds in favorable years to 4,000 pounds in unfavorable years.

Continuous heavy grazing by livestock decreases the proportion of preferred forage plants, such as little bluestem, indiangrass, and Engelmann-daisy. These are replaced by less desirable forage plants, such as sideoats grama, Texas wintergrass, and buffalograss. If heavy grazing continues for many years, such plants as threeawn, Texas wintergrass, Ashe juniper, Texas persimmon, pricklypear, and mesquite dominate.

Areas of this soil provide fair habitat for deer, doves, and quail. The lack of adequate cover is a limiting factor for deer.

This Nuvalde soil is in capability subclass IIe and in the Clay Loam range site.

16—Oakalla silty clay loam. This deep, nearly level soil is on flood plains of major streams. Slopes are smooth to slightly concave and range from 0 to 2 percent. Areas are long-oval or long-narrow and range from 15 to 30 acres.

Typically, the surface layer of this Oakalla soil is dark gray silty clay loam 15 inches thick. The next layer is dark grayish brown silty clay loam to a depth of 26 inches. The subsoil is brown silty clay loam to a depth of 48 inches. Below that to a depth of 60 inches is grayish brown silty clay loam that contains bodies of calcium carbonate. Reaction of the soil is moderately alkaline throughout (fig. 11).

This soil is well drained. Surface runoff is slow. Permeability is moderate. The available water capacity is high. Natural fertility is high. The root zone is deep, and air, water, and roots move through the soil easily. The hazard of water erosion is slight. This soil receives runoff and is flooded about once in 1 to 4 years for a period of 12 to 36 hours.

Included with this soil in mapping are small, long, oval areas of Nuvalde, Boerne, and Orif gravelly soils. The included soils make up 5 to 15 percent of each mapped area.

Figure 11.—Profile of Oakalla silty clay loam. Note the thick, dark surface layer and the thin, gravelly layer in the lower part. This soil is on flood plains and is high in natural fertility. (The scale is in inches.)

This Oakalla soil is used as cropland and rangeland. Grain sorghum, oats, wheat, tame pasture, and grass for hay are the principal crops.

This soil is well suited to crops and improved pasture. Keeping crop residue on the surface helps to improve fertility, reduce crusting, control water erosion, increase water infiltration, and conserve moisture. It also helps to improve soil tilth and water intake. This soil is best tilled at a low soil moisture content. Crops respond well to fertilization. Nitrogen and phosphorus help improve yields. Because of the high lime content of this soil, yellowing of the plant leaves, or iron chlorosis, is a problem.

For urban uses this soil is limited by the flood hazard, seepage, and corrosivity to uncoated steel for underground pipe. This soil is moderately well suited to most recreational uses. The silty clay loam surface layer and flooding are the most limiting features.

The potential rangeland plant community is a grassed bottom land that has scattered trees. Typically, the dominant plants are—

- little bluestem, indiangrass, big bluestem, switchgrass, and eastern gamagrass—35 percent
- sideoats grama and cane bluestem—10 percent
- other mid grasses, such as Texas cupgrass, pinhole bluestem, meadow dropseed, vine-mesquite, tall dropseed, southwestern bristlegrass, Canada wildrye, purple tridens, broadleaf uniola, and buffalograss—35 percent
- woody plants, such as baldcypress, live oak, pecan, sycamore, elm, wild grape, and greenbrier—15 percent
- forbs, such as Engelmann-daisy, bushsunflower, and Maximilian sunflower—5 percent

Total annual dry weight forage production per acre on this soil in excellent condition ranges from 6,000 pounds in favorable years to 3,500 pounds in unfavorable years.

Continuous heavy grazing by livestock decreases the proportion of preferred forage plants, such as little bluestem, big bluestem, eastern gamagrass, indiangrass, and Engelmann-daisy. These are replaced by less desirable forage plants, such as sideoats grama, pinhole bluestem, and buffalograss. If heavy grazing continues for many years, oaks, elm, and mesquite form a dense stand with an understory of such plants as Texas wintergrass, common bermudagrass, and Ashe juniper.

Areas of this soil provide good habitat for deer, turkeys, squirrels, and furbearing animals. Nesting areas for doves and songbirds are plentiful.

This Oakalla soil is in capability subclass IIw and in the Loamy Bottomland range site.

17—Orif-Boerne association, gently undulating. This association consists of loamy and gravelly soils on flood plains. Areas are adjacent to, and 3 to 6 feet above, the stream channels. Mapped areas are long and narrow and parallel to the channels of major perennial streams. Areas are 30 to 160 acres. Slopes range from 1 to 5 percent.

Orif and Boerne soils are in all mapped areas. Orif soils make up 30 to 80 percent of each mapped area and average about 60 percent of the association. Boerne soils make up 20 to 70 percent of each mapped area and average about 35 percent. Long, narrow areas of Oakalla soils and perennial stream channels 30 to 75 feet wide make up an average of 5 percent of the association.

The mapped areas of this association are large and the composition is variable. Mapping has been controlled well enough, however, for the anticipated uses of the areas.

Typically, the Orif soils in this association have a surface layer of grayish brown gravelly sandy loam about 6 inches thick. The next layer is light brownish gray

gravelly fine sandy loam to a depth of 16 inches. From 16 to 60 inches are layers of light brownish gray very gravelly loamy fine sand and fine sandy loam that have 70 to 90 percent rounded, waterworn pebbles and cobbles of limestone. Reaction of the soil is moderately alkaline throughout (fig. 12).

Typically, the Boerne soils in this association have a surface layer of grayish brown fine sandy loam 12 inches thick. The subsoil is brown fine sandy loam to a depth of 31 inches and contains a few threads of calcium carbonate. This grades to brown fine sandy loam that contains an estimated 25 percent threads, soft bodies, and cemented concretions of calcium carbonate to a depth of 60 inches. Reaction of the soil is moderately alkaline throughout. The texture of the surface layer ranges to loam.

The soils in this association are well drained. Surface runoff is slow to medium. Permeability is moderately rapid to rapid. The available water capacity is low to medium. Natural fertility is low. The hazard of water erosion is severe. Areas of these soils are flooded from twice each year to once in four years for a period of 24 to 48 hours. Recent flooding has lodged trash in tree limbs as much as 20 feet above the ground. In some places the gravelly substratum of the Orif soils is exposed because the topsoil has been washed away by floodwater.

Figure 12.—Profile of Orif gravelly sandy loam. Very gravelly layers are below a depth of about 1 foot.

These soils are poorly suited to cropland and pastureland. Flooding, gravel content, and low available water capacity are the most limiting features.

For urban and recreational uses, these soils are limited by flooding and the content of gravel.

The potential rangeland plant community on the Orif and Boerne soils is a postclimax community of trees. Typically, the dominant plants are—

- little bluestem, indiangrass, big bluestem, switchgrass, and eastern gamagrass—35 percent
- sideoats grama and cane bluestem—10 percent
- other midgrasses, such as Texas cupgrass, pinhole bluestem, meadow dropseed, vine-mesquite, tall dropseed, southwestern bristlegrass, Canada wildrye, purple tridens, broadleaf uniola, and buffalograss—35 percent
- woody plants, such as baldcypress, live oak, pecan, sycamore, elm, wild grape, and greenbrier—15 percent
- forbs, such as Engelmann-daisy, bushsunflower, and Maximilian sunflower—5 percent

Total annual dry weight forage production per acre on these soils in excellent condition ranges from 5,500 pounds in favorable years to 3,000 pounds in unfavorable years.

Continuous heavy grazing by livestock decreases the proportion of preferred forage plants, such as little bluestem, big bluestem, eastern gamagrass, indiangrass, and Engelmann-daisy. These are replaced by less desirable forage plants, such as sideoats grama, pinhole bluestem, and buffalograss. If heavy grazing continues for many years, oaks, elm, and mesquite form a dense stand with an understory of such plants as Texas wintergrass, common bermudagrass, and Ashe juniper.

Areas of these soils provide fair habitat for deer, turkeys, squirrels, and furbearing animals. Nesting areas for doves and songbirds are plentiful.

The soils of this association are in capability subclass VIs and in the Loamy Bottomland range site.

18—Tarpley clay, 1 to 3 percent slopes. This gently sloping, shallow soil is on uplands. Slopes are convex. Mapped areas are roughly circular and range from 40 to 120 acres.

Typically, the surface layer of this soil is dark reddish brown clay 9 inches thick. The subsoil is reddish brown clay to a depth of 19 inches. This rests abruptly on indurated limestone bedrock. Reaction of the soil is neutral throughout.

This soil is well drained. Surface runoff is medium. Permeability is slow. The available water capacity is very low. The root zone is shallow. The hazard of water

erosion is moderate. Most areas have less than 10 percent chert fragments on the surface and in the soil, but some small areas have up to 20 percent.

Included with this soil in mapping are small, irregularly shaped areas of Anhalt soil, circular areas of Doss soil, and occasional small outcrops of rock at the same level as the soil surface. The included areas make up as much as 10 percent of each mapped area.

Areas of this Tarpley soil are used as cropland and rangeland. Grain sorghum and oats are the main cultivated crops.

This soil is moderately well suited to crops and improved pasture. Shallow rooting depth and low available water capacity are the most limiting features. Keeping crop residue on the soil surface helps to control water erosion, conserve moisture, improve soil tilth, and increase water intake. Contour farming is needed in most areas to control water erosion. If cuts or excavations exceed about 13 inches, there is a hazard of cutting into indurated limestone bedrock.

This soil is poorly suited to most urban uses. Shallow depth to rock, corrosivity to uncoated steel, and shrinking and swelling are the most limiting features. This soil is poorly suited to recreation uses. Shallow depth to rock and clayey texture are limiting features that are not easily overcome.

The potential rangeland plant community is a tall grass, post oak, and live oak savannah. Typically, the dominant plants are—

- little bluestem—50 percent
- indiangrass—15 percent
- other mid grasses, such as sideoats grama, Texas cupgrass, cane bluestem, tall dropseed, vine-mesquite, curlymesquite, and buffalograss—25 percent
- woody plants, such as post oak, blackjack oak, live oak, and greenbrier—5 percent
- forbs, such as Engelmann-daisy, bushsunflower, and sensitivebrier—5 percent

Total annual dry weight forage production per acre on this soil in excellent condition ranges from 5,000 pounds in favorable years to 2,500 pounds in unfavorable years.

Continuous heavy grazing by livestock decreases the proportion of preferred forage plants, such as little bluestem, indiangrass, and Engelmann-daisy. These are replaced by less desirable forage plants, such as sideoats grama, cane bluestem, buffalograss, and post oak. If heavy grazing continues for many years, such plants as threeawn, Texas wintergrass, Ashe juniper, Texas persimmon, pricklypear, and mesquite dominate.

Areas of this soil provide fair habitat for deer, turkeys, squirrels, and furbearing animals. Nesting areas for doves and songbirds are plentiful.

This Tarpley soil is in capability subclass IIIe and in the Redland range site.

19—Tarpley-Comfort association, gently undulating. This association consists of shallow, gently undulating, stony and clayey soils on uplands. These soils are on ridgetops and are underlain by limestone. Slopes are convex and range from 1 to 5 percent. Mapped areas are irregular in shape and range from 60 to 400 acres.

Tarpley soils are in all mapped areas. They average about 67 percent of each mapped area but range from 60 to 70 percent. Comfort soils are in all mapped areas and average about 22 percent. The rest of the association is limestone outcrops and small areas of Anhalt soils. The limestone outcrops are 3 to 10 feet across or are irregularly shaped ledges 12 to 60 feet wide and 50 to 600 feet long in a continuous band. The outcrops are at the surface to as much as 30 inches above the soil surface. Some of the outcrops are smooth; some are solution pitted or "honeycombed." In places these soils have 10 to 15 percent of the surface covered with fragments of limestone that are dominantly 3 to 10 inches in diameter. The outcrops and Anhalt soils make up to 5 to 20 of each mapped area and average about 8 percent.

Mapped areas of this unit are large, and the composition is variable. Mapping has been controlled well enough, however, for the anticipated uses of the soils.

Typically, the Tarpley soils have a surface layer of dark reddish brown stony clay about 8 inches thick. The next layer is reddish brown clay to a depth of 19 inches. This rests abruptly on fractured limestone bedrock. Reaction of the soil is neutral throughout.

Typically, the Comfort soils have a surface layer of dark reddish brown stony clay 9 inches thick. The next layer is reddish brown stony clay to a depth of 17 inches. This rests abruptly on crystalline, limestone bedrock. Reaction of the soil is neutral throughout.

The soils in this association are well drained. Surface runoff is medium. Permeability is slow. The available water capacity is low to very low. The root zone is shallow. The hazard of water erosion is severe.

The soils in this association are poorly suited to cropland and tame pastureland. Stoniness, shallow rooting depth, and low to very low available water capacity are the most limiting features.

The soils in this association are poorly suited to urban uses. Shallow depth to rock, corrosivity to uncoated steel, and shrinking and swelling are the most limiting features. The soils are poorly suited to recreation uses. Shallow depth to rock, slope, stoniness, and clayey texture are limiting features that are not easily overcome.

The potential rangeland plant community on the Tarpley soil is a tall grass, live oak savannah. Typically, the dominant plants are—

- little bluestem—50 percent
- indiangrass—15 percent
- sideoats grama and other mid grasses, such as Texas cupgrass, cane bluestem, plains lovegrass, vine-mesquite, tall dropseed, and buffalograss—20 percent

- woody plants, such as live oak, post oak, elm, hackberry, and greenbrier—10 percent
- forbs, such as Engelmann-daisy, bushsunflower, and sensitivebrier—5 percent

Total annual dry weight forage production per acre from this soil in excellent condition ranges from 5,000 pounds in favorable years to 2,500 pounds in unfavorable years.

The potential rangeland plant community on the Comfort soil is a tall grass, post oak savannah. Typically, the dominant plants are—

- little bluestem—50 percent
- indiangrass and big bluestem—20 percent
- sideoats grama and other mid grasses, such as Texas cupgrass, cane bluestem, plains lovegrass, vine-mesquite, tall dropseed, and buffalograss—20 percent
- woody plants, such as live oak, elm, hackberry, and greenbrier; and forbs, such as Engelmann-daisy, bushsunflower, and sensitivebrier—10 percent

Total annual dry weight forage production per acre from this soil in excellent condition ranges from 6,000 pounds in favorable years to 3,000 pounds in unfavorable years.

Continuous heavy grazing by livestock on the Tarpley and Comfort soils decreases the proportion of preferred forage plants, such as little bluestem, indiangrass, and Engelmann-daisy. These are replaced by less desirable forage plants, such as sideoats grama, pinhole bluestem, buffalograss, live oak, and Ashe juniper. If heavy grazing continues for many years, Ashe juniper forms a dense stand with an understory of such plants as threeawn, Texas wintergrass, buffalograss, Texas persimmon, and agarito.

Areas of these soils provide fair habitat for deer, turkeys, squirrels, and furbearing animals. Nesting areas for doves and songbirds are plentiful.

These soils are in capability subclass VIs. Tarpley soils are in the Redland range site, and Comfort soils are in the Low Stony Hill range site.

use and management of the soils

This soil survey is an inventory and evaluation of the soils in the survey area. It can be used to adjust land uses to the limitations and potentials of natural resources and the environment. Also, it can help avoid soil-related failures in land uses.

In preparing a soil survey, soil scientists, conservationists, and others collect extensive field data about the nature and behavior characteristics of the soils. They collect data on erosion, droughtiness, flooding, and other factors that affect various soil uses and management. Field experience and collected data on soil properties and performance are used as a basis in predicting soil behavior.

Information in this section can be used to plan the use and management of soils for crops and pasture; as rangeland; as sites for buildings, sanitary facilities, highways and other transportation systems, and parks and other recreation facilities; and for wildlife habitat. It can be used to identify the potentials and limitations of each soil for specific land uses and to help prevent construction failures caused by unfavorable soil properties.

Planners and others using soil survey information can evaluate the effect of specific land uses on productivity and on the environment in all or part of the survey area. The survey can help planners to maintain or create a land use pattern in harmony with the natural soil.

Contractors can use this survey to locate sources of sand and gravel, roadfill, and topsoil. They can use it to identify areas where bedrock or very firm soil layers can cause difficulty in excavation.

Health officials, highway officials, engineers, and others may also find this survey useful. The survey can help them plan the safe disposal of wastes and locate sites for pavements, sidewalks, campgrounds, playgrounds, lawns, and trees and shrubs.

crops and pasture

General management needed for crops and pasture is suggested in this section. The crops or pasture plants best suited to the soils, including some not commonly grown in the survey area, are identified; the system of land capability classification used by the Soil Conservation Service is explained; and the estimated yields of the main crops and hay and pasture plants are listed for each soil.

Planners of management systems for individual fields or farms should consider the detailed information given in the description of each soil under "Detailed soil map units." Specific information can be obtained from the local office of the Soil Conservation Service or the Cooperative Extension Service.

More than 46,000 acres in the survey area was used as cropland and pastureland in 1978, according to the records of the Boerne field office, Soil Conservation Service. Of this total, 10,350 acres was used as permanent pastureland; 24,000 acres mainly for forage sorghum; and 12,000 acres for oats and wheat.

The soils in Kendall County have good potential for increased production of food. About 24,000 acres of potentially good cropland is currently used as rangeland, and about 10,350 acres is used as pastureland. In addition to the reserve productive capacity represented by this land, food production can also be increased considerably by extending the latest crop production technology to all cropland in the survey area. This soil survey can help facilitate the application of such technology.

The acreage used as rangeland has gradually been decreasing as more and more land is used for urban development. In 1978 there were about 9,000 acres of urban and built-up land in the survey area, and this figure is expected to grow at the rate of about 1,000 acres per year. The use of this soil survey to help make land use decisions that will influence the future role of farming in the survey area is discussed in the section "General soil map units."

pastureland and hayland

Suitability of grasses to soils is the foremost consideration in developing pastureland and hayland. Careful consideration should also be given to the possibility of developing a year-long forage program by using a combination of forage plants. This program can include grazing both warm- and cool-season grasses during their respective growing season, or wintering the animals on field-cured, warm-season plants. One possible combination is to provide improved bermudagrass forage from May to November and weeping lovegrass, King Ranch bluestem, or kleingrass forage from November to May. If pastureland is used with rangeland, improved bermudagrass can be used for warm-season grazing and livestock can winter on field-cured native grasses and protein supplement.

If fertilizer is applied in several increments throughout the growing season, yields of high quality forage can be

improved on all soils. Sustained high production is achieved only through proper management of both grass and soil. Proper management includes fertilization, weed control, and regulation of grazing.

The need for fertilizer varies among different groups of soil. The need mainly depends on the past use of the soil, the amount of erosion that has taken place, and the kind of soil. Generally, improved grasses on all soils benefit from applications of nitrogen and phosphorus. Most soils contain enough potash. The kind and amount of fertilizer needed in relation to the selected plants and the desired yield is best determined by a chemical soil test. Fertilizers should be applied and incorporated into the soil surface by disking 2 or 3 weeks before grasses are sprigged or seeded.

Controlling weeds reduces the competition for moisture and plant nutrients and provides growing space for the desirable grasses. Weeds are controlled by mowing.

Grazing should be regulated. One way to avoid overgrazing is to have proper distribution of livestock water. Another way is to have several areas of pasture and rotate the grazing among them. Generally, pasture of a single grass species is easier to manage than one of mixed grass species.

yields per acre

The average yields per acre that can be expected of the principal crops under a high level of management are shown in table 6. In any given year, yields may be higher or lower than those indicated in the table because of variations in rainfall and other climatic factors.

The yields are based mainly on the experience and records of farmers, conservationists, and extension agents. Available yield data from nearby counties and results of field trials and demonstrations are also considered.

The management needed to obtain the indicated yields of the various crops depends on the kind of soil and the crop. Management can include drainage, erosion control, and protection from flooding; the proper planting and seeding rates; suitable high-yielding crop varieties; appropriate and timely tillage; control of weeds, plant diseases, and harmful insects; favorable soil reaction and optimum levels of nitrogen, phosphorus, potassium, and trace elements for each crop; effective use of crop residue, barnyard manure, and green-manure crops; and harvesting that insures the smallest possible loss.

The estimated yields reflect the productive capacity of each soil for each of the principal crops. Yields are likely to increase as new production technology is developed. The productivity of a given soil compared with that of other soils, however, is not likely to change.

Crops other than those shown in table 6 are grown in the survey area, but estimated yields are not listed because the acreage of such crops is small. The local office of the Soil Conservation Service or of the Cooperative Extension Service can provide information about the management and productivity of the soils.

land capability classification

Land capability classification shows, in a general way, the suitability of soils for most kinds of field crops. Crops that require special management are excluded. The soils are grouped according to their limitations for field crops, the risk of damage if they are used for crops, and the way they respond to management. The grouping does not take into account major and generally expensive landforming that would change slope, depth, or other characteristics of the soils, nor does it consider possible but unlikely major reclamation projects. Capability classification is not a substitute for interpretations designed to show suitability and limitations of groups of soils for rangeland, for woodland, and for engineering purposes.

In the capability system, soils are generally grouped at three levels: capability class, subclass, and unit. Only class and subclass are used in this survey. These levels are defined in the following paragraphs.

Capability classes, the broadest groups, are designated by Roman numerals I through VIII. The numerals indicate progressively greater limitations and narrower choices for practical use. The classes are defined as follows:

Class I soils have slight limitations that restrict their use. There are no class I soils in Kendall County.

Class II soils have moderate limitations that reduce the choice of plants or that require moderate conservation practices.

Class III soils have severe limitations that reduce the choice of plants or that require special conservation practices, or both.

Class IV soils have very severe limitations that reduce the choice of plants or that require very careful management, or both.

Class V soils are not likely to erode but have other limitations, impractical to remove, that limit their use.

Class VI soils have severe limitations that make them generally unsuitable for cultivation.

Class VII soils have very severe limitations that make them unsuitable for cultivation.

Class VIII soils and miscellaneous areas have limitations that nearly preclude their use for commercial crop production. There are no class VIII soils in Kendall County.

Capability subclasses are soil groups within one class. They are designated by adding a small letter, *e, w, s,* or *c,* to the class numeral, for example, IIe. The letter *e* shows that the main limitation is risk of erosion unless close-growing plant cover is maintained; *w* shows that water in or on the soil interferes with plant growth or cultivation (in some soils the wetness can be partly corrected by artificial drainage); *s* shows that the soil is limited mainly because it is shallow, droughty, or stony;

and *c*, used in only some parts of the United States, shows that the chief limitation is climate that is very cold or very dry.

In class I there are no subclasses because the soils of this class have few limitations. Class V contains only the subclasses indicated by *w, s,* or *c* because the soils in class V are subject to little or no erosion. They have other limitations that restrict their use to pasture, rangeland, woodland, wildlife habitat, or recreation.

The acreage of soils in each capability class and subclass is shown in table 7. The capability classification of each map unit is given in the section "Detailed soil map units."

rangeland

William W. Reeder, range conservationist, Soil Conservation Service, helped to prepare this section.

According to field office records of the Soil Conservation Service in Boerne, about 373,450 acres, or about 87 percent, of the agricultural land in Kendall County is in rangeland. Rangeland mainly consists of native vegetation which is used for the production of domestic livestock and for deer and other wildlife.

Rangeland is the major renewable natural resource in the county, and raising livestock is the major enterprise. Cattle, sheep, and angora goats graze throughout the survey area. Recreation areas and the sale of hunting rights for deer and wild turkey that use rangeland for food and cover are additional profitable enterprises in many areas of this county.

The soils on the limestone hills produce live oak, Texas oak, and other browse plants, as well as grasses and forbs. This area is well suited to grazing by sheep, goats, and cattle. The deeper soils in the valleys and lower lying plains produce native mid and tall grass prairie intermixed with some forbs and woody plants.

On all the soils in this county, it is necessary to keep livestock numbers in balance with forage yields that fluctuate according to the seasonal rainfall pattern. Dry years result in decreased forage yields and in reduction of the plant cover. Seasonal rainfall has varying effects, depending on the time it falls. Rainfall generally occurs in spring and early in summer, and 60 to 70 percent of the total annual forage is produced during this period. Another period of growth follows the rains of August, September, and October. The deeper, more fertile soils produce some grasses and forbs that grow late in winter and early in spring when rainfall is favorable.

In areas that have similar climate and topography, differences in the kind and amount of vegetation produced on rangeland are closely related to the kind of soil. Effective management is based on the relationship between the soils and vegetation and water.

A range site is a distinctive kind of rangeland that produces a characteristic natural plant community that differs from natural plant communities on other range sites in kind, amount, and proportion of range plants. The relationship between soils and vegetation was established during this survey; thus, range sites generally can be determined directly from the soil map. Soil properties that affect moisture supply and plant nutrients have the greatest influence on the productivity of range plants. Soil reaction, salt content, and seepage following above-average rainfall are also important.

Total production, as shown in the soil descriptions, is the amount of vegetation that can be expected to grow annually on well managed rangeland that is supporting the potential natural plant community. It includes all vegetation, whether or not it is palatable to grazing animals. It includes the current year's growth of leaves, twigs, and fruits of woody plants. It does not include the increase in stem diameter of trees and shrubs. It is expressed in pounds per acre of air-dry vegetation for favorable and unfavorable years. In a favorable year, the amount and distribution of precipitation and the temperatures make growing conditions substantially better than average. In an unfavorable year, growing conditions are well below average, generally because of low available soil moisture.

The grasses, forbs, and shrubs that make up most of the potential natural plant community on each soil are listed in each map unit by common name. The expected percentage of the total annual production is given for the characteristic vegetation. The amount that can be used as forage depends on the kinds of grazing animals and on the grazing season.

Range management requires a knowledge of the kinds of soil and of the potential natural plant community. It also requires an evaluation of the present range condition. Range condition is determined by comparing the present plant community with the potential natural plant community on a particular range site. The more closely the existing community resembles the potential community, the better the range condition. Range condition is an ecological rating only. It does not have a specific meaning that pertains to the present plant community in a given use.

The objective in range management is to control grazing so that the plants growing on a site are about the same in kind and amount as the potential natural plant community for that site. Such management generally results in the optimum production of vegetation, reduction of undesirable brush species, conservation of water, and control of water erosion and soil blowing. Sometimes, however, a range condition somewhat below the potential meets grazing needs, provides wildlife habitat, and protects soil and water resources.

recreation

The soils of the survey area are rated in table 8 according to limitations that affect their suitability for recreation. The ratings are based on restrictive soil

features, such as slope and texture of the surface layer. Susceptibility to flooding is considered. Not considered in the ratings, but important in evaluating a site, are the location and accessibility of the area, the size and shape of the area and its scenic quality, vegetation, access to water, potential water impoundment sites, and access to public sewerlines. The capacity of the soil to absorb septic tank effluent and the ability of the soil to support vegetation are also important. Soils subject to flooding are limited for recreation use by the duration and intensity of flooding and the season when flooding occurs. In planning recreation facilities, onsite assessment of the height, duration, intensity, and frequency of flooding is essential.

In table 8, the degree of soil limitation is expressed as slight, moderate, or severe. *Slight* means that soil properties are generally favorable and that limitations are minor and easily overcome. *Moderate* means that limitations can be overcome or alleviated by planning, design, or special maintenance. *Severe* means that soil properties are unfavorable and that limitations can be offset only by costly soil reclamation, special design, intensive maintenance, limited use, or by a combination of these measures.

The information in table 8 can be supplemented by other information in this survey, for example, interpretations for septic tank absorption fields in table 11 and interpretations for dwellings without basements and for local roads and streets in table 10.

Camp areas require site preparation such as shaping and leveling the tent and parking areas, stabilizing roads and intensively used areas, and installing sanitary facilities and utility lines. Camp areas are subject to heavy foot traffic and some vehicular traffic. The best soils have mild slopes and are not wet or subject to flooding during the period of use. The surface has few or no stones or boulders, absorbs rainfall readily but remains firm, and is not dusty when dry. Strong slopes and stones or boulders can greatly increase the cost of constructing campsites.

Picnic areas are subject to heavy foot traffic. Most vehicular traffic is confined to access roads and parking areas. The best soils for picnic areas are firm when wet, are not dusty when dry, are not subject to flooding during the period of use, and do not have slopes or stones or boulders that increase the cost of shaping sites or of building access roads and parking areas.

Playgrounds require soils that can withstand intensive foot traffic. The best soils are almost level and are not wet or subject to flooding during the season of use. The surface is free of stones and boulders, is firm after rains, and is not dusty when dry. If grading is needed, the depth of the soil over bedrock or a hardpan should be considered.

Paths and trails for hiking, horseback riding, and bicycling should require little or no cutting and filling. The best soils are not wet, are firm after rains, are not dusty when dry, and are not subject to flooding more than once a year during the period of use. They have moderate slopes and few or no stones or boulders on the surface.

Golf fairways are subject to heavy foot traffic and some light vehicular traffic. Cutting or filling may be required. The best soils for use as golf fairways are firm when wet, are not dusty when dry, and are not subject to prolonged flooding during the period of use. They have moderate slopes and no stones or boulders on the surface. The suitability of the soil for tees or greens is not considered in rating the soils.

wildlife habitat

Wildlife is an important source of recreation and income in Kendall County. Most of the land supporting wildlife is leased for hunting.

A wide variety of wildlife exists in the county because of the great diversity of soils and the resultant assemblages of vegetation growing on each soil. Important game animals include white-tailed deer, bobwhite quail, mourning doves, tree squirrels, and wild turkeys. Furbearing animals include bobcats, raccoon, ring-tailed cats, skunks, opossum, fox, and coyote. Some ranches in the county support various species of exotic big game animals. The most common are axis deer, sika deer, fallow deer, red deer, blackbuck antelope, barbary sheep, and mouflon sheep.

Numerous farm ponds and the many streams and rivers in the county attract various migratory waterfowl. Most of the ponds, streams, and rivers support fish. Common fish are black bass, crappie, channel catfish, yellow catfish, and various kinds of sunfish.

Fish and wildlife resources are of great economic importance to Kendall County. This section discusses the potential of wildlife elements and the various wildlife habitats in the county.

Soils affect the kind and amount of vegetation that is available to wildlife as food and cover. They also affect the construction of water impoundments. The kind and abundance of wildlife depend largely on the amount and distribution of food, cover, and water. Wildlife habitat can be created or improved by planting appropriate vegetation, by maintaining the existing plant cover, or by promoting the natural establishment of desirable plants.

In table 9, the soils in the survey area are rated according to their potential for providing habitat for various kinds of wildlife. This information can be used in planning parks, wildlife refuges, nature study areas, and other developments for wildlife; in selecting soils that are suitable for establishing, improving, or maintaining specific elements of wildlife habitat; and in determining the intensity of management needed for each element of the habitat.

The potential of the soil is rated good, fair, poor, or very poor. A rating of *good* indicates that the element or kind of habitat is easily established, improved, or maintained. Few or no limitations affect management,

and satisfactory results can be expected. A rating of *fair* indicates that the element or kind of habitat can be established, improved, or maintained in most places. Moderately intensive management is required for satisfactory results. A rating of *poor* indicates that limitations are severe for the designated element or kind of habitat. Habitat can be created, improved, or maintained in most places, but management is difficult and must be intensive. A rating of *very poor* indicates that restrictions for the element or kind of habitat are very severe and that unsatisfactory results can be expected. Creating, improving, or maintaining habitat is impractical or impossible.

The elements of wildlife habitat are described in the following paragraphs.

Grain and seed crops are domestic grains and seed-producing herbaceous plants. Soil properties and features that affect the growth of grain and seed crops are depth of the root zone, texture of the surface layer, lime content, available water capacity, slope, surface stoniness, and flood hazard. Soil temperature and soil moisture are also considerations. Examples of grain and seed crops are corn, wheat, oats, and barley.

Grasses and legumes are domestic perennial grasses and herbaceous legumes. Soil properties and features that affect the growth of grasses and legumes are depth of the root zone, texture of the surface layer, available water capacity, surface stoniness, lime content, flood hazard, and slope. Soil temperature and soil moisture are also considerations. Examples of grasses and legumes are fescue, lovegrass, bromegrass, clover, and alfalfa.

Wild herbaceous plants are native or naturally established grasses and forbs, including weeds. Soil properties and features that affect the growth of these plants are depth of the root zone, texture of the surface layer, available water capacity, surface stoniness, and flood hazard. Soil temperature and soil moisture are also considerations. Examples of wild herbaceous plants are johnsongrass, Texas wintergrass, Texas panicum, vine-mesquite, switchgrass, vetch, annual lespedeza, partridge pea, and Maximilian sunflower.

Shrubs are bushy woody plants that produce fruit, buds, twigs, bark, and foliage. Soil properties and features that affect the growth of shrubs are depth of the root zone, available water capacity, lime content, and soil moisture. Examples of shrubs are condalia, ephedra, sumac, wild plum, forestiera, and acacia.

Wetland plants are annual and perennial wild herbaceous plants that grow on moist or wet sites. Submerged or floating aquatic plants are excluded. Soil properties and features affecting wetland plants are texture of the surface layer, wetness, reaction, salinity, slope, and surface stoniness. Examples of wetland plants are smartweed, wild millet, wildrice, saltgrass, cordgrass, rushes, sedges, and reeds.

Shallow water areas have an average depth of less than 5 feet. Some are naturally wet areas. Others are created by dams, levees, or other water-control structures. Soil properties and features affecting shallow water areas are depth to bedrock, wetness, surface stoniness, slope, and permeability. Examples of shallow water areas are marshes, waterfowl feeding areas, and ponds.

The habitat for various kinds of wildlife is described in the following paragraphs.

Habitat for openland wildlife consists of cropland, pasture, meadows, and areas that are overgrown with grasses, herbs, shrubs, and vines. These areas produce grain and seed crops, grasses and legumes, and wild herbaceous plants. The wildlife attracted to these areas include bobwhite quail, doves, meadowlarks, field sparrows, cottontails, jackrabbits, and red fox.

Habitat for wetland wildlife consists of open, marshy or swampy shallow water areas. Some of the wildlife attracted to such areas are ducks, geese, herons, shore birds, muskrats, mink, and beaver.

Habitat for rangeland wildlife consists of areas of shrubs and wild herbaceous plants. Wildlife attracted to rangeland include deer and meadowlark.

engineering

This section provides information for planning land uses related to urban development and to water management. Soils are rated for various uses, and the most limiting features are identified. The ratings are given in the following tables: Building site development, Sanitary facilities, Construction materials, and Water management. The ratings are based on observed performance of the soils and on the estimated data and test data in the "Soil properties" section.

Information in this section is intended for land use planning, for evaluating land use alternatives, and for planning site investigations prior to design and construction. The information, however, has limitations. For example, estimates and other data generally apply only to that part of the soil within a depth of 5 or 6 feet. Because of the map scale, small areas of different soils may be included within the mapped areas of a specific soil.

The information is not site specific and does not eliminate the need for onsite investigation of the soils or for testing and analysis by personnel experienced in the design and construction of engineering works.

Government ordinances and regulations that restrict certain land uses or impose specific design criteria were not considered in preparing the information in this section. Local ordinances and regulations need to be considered in planning, in site selection, and in design.

Soil properties, site features, and observed performance were considered in determining the ratings in this section. During the fieldwork for this soil survey, determinations were made about grain-size distribution, liquid limit, plasticity index, soil reaction, depth to bedrock, hardness of bedrock within 5 to 6 feet of the

surface, slope, likelihood of flooding, natural soil structure aggregation, and soil density. Estimates were made for erodibility, permeability, corrosivity, shrink-swell potential, available water capacity, and other behavioral characteristics affecting engineering uses.

This information can be used to (1) evaluate the potential of areas for residential, commercial, industrial, and recreation uses; (2) make preliminary estimates of construction conditions; (3) evaluate alternative routes for roads, streets, highways, pipelines, and underground cables; (4) evaluate alternative sites for sanitary landfills, septic tank absorption fields, and sewage lagoons; (5) plan detailed onsite investigations of soils and geology; (6) locate potential sources of gravel, sand, earthfill, and topsoil; (7) plan irrigation systems, ponds, terraces, and other structures for soil and water conservation; and (8) predict performance of proposed small structures and pavements by comparing the performance of existing similar structures on the same or similar soils.

The information in the tables, along with the soil maps, the soil descriptions, and other data provided in this survey can be used to make additional interpretations.

Some of the terms used in this soil survey have a special meaning in soil science and are defined in the Glossary.

building site development

Table 10 shows the degree and kind of soil limitations that affect shallow excavations, dwellings with and without basements, small commercial buildings, local roads and streets, and lawns and landscaping. The limitations are considered *slight* if soil properties and site features are generally favorable for the indicated use and limitations are minor and easily overcome; *moderate* if soil properties or site features are not favorable for the indicated use and special planning, design, or maintenance is needed to overcome or minimize the limitations; and *severe* if soil properties or site features are so unfavorable or so difficult to overcome that special design, significant increases in construction costs, and possibly increased maintenance are required. Special feasibility studies may be required where the soil limitations are severe.

Shallow excavations are trenches or holes dug to a maximum depth of 5 or 6 feet for basements, graves, utility lines, open ditches, and other purposes. The ratings are based on soil properties, site features, and observed performance of the soils. The ease of digging, filling, and compacting is affected by the depth to bedrock or a very firm dense layer; stone content; soil texture; and slope. The time of the year that excavations can be made is affected by the susceptibility of the soil to flooding. The resistance of the excavation walls or banks to sloughing or caving is affected by soil texture.

Dwellings and small commercial buildings are structures built on shallow foundations on undisturbed soil. The load limit is the same as that for single-family dwellings no higher than three stories. Ratings are made for small commercial buildings without basements, for dwellings with basements, and for dwellings without basements. The ratings are based on soil properties, site features, and observed performance of the soils. Flooding and shrink-swell potential can cause the movement of footings. Depth to bedrock, large stones, and flooding affect the ease of excavation and construction. Landscaping and grading that require cuts and fills of more than 5 to 6 feet are not considered.

Local roads and streets have an all-weather surface and carry automobile and light truck traffic all year. They have a subgrade of cut or fill soil material, a base of gravel, crushed rock, or stabilized soil material, and a flexible or rigid surface. Cuts and fills are generally limited to less than 6 feet. The ratings are based on soil properties, site features, and observed performance of the soils. Depth to bedrock, flooding, large stones, and slope affect the ease of excavating and grading. Soil strength (as inferred from the engineering classification of the soil) and shrink-swell potential affect the traffic supporting capacity.

Lawns and landscaping require soils on which turf and ornamental trees and shrubs can be established and maintained. The ratings are based on soil properties, site features, and observed performance of the soils. Depth to bedrock and the available water capacity in the upper 40 inches affect plant growth. Flooding, slope, stoniness, and the amount of sand, clay, or organic matter in the surface layer affect trafficability after vegetation is established.

sanitary facilities

Table 11 shows the degree and the kind of soil limitations that affect septic tank absorption fields, sewage lagoons, and sanitary landfills. The limitations are considered *slight* if soil properties and site features are generally favorable for the indicated use and limitations are minor and easily overcome; *moderate* if soil properties or site features are not favorable for the indicated use and special planning, design, or maintenance is needed to overcome or minimize the limitations; and *severe* if soil properties or site features are so unfavorable or so difficult to overcome that special design, significant increases in construction costs, and possibly increased maintenance are required.

Table 11 also shows the suitability of the soils for use as daily cover for landfills. A rating of *good* indicates that soil properties and site features are favorable for the use and good performance and low maintenance can be expected; *fair* indicates that soil properties and site features are moderately favorable for the use and one or more soil properties or site features make the soil less desirable than the soils rated good; and *poor* indicates that one or more soil properties or site features are unfavorable for the use and that overcoming the unfavorable properties requires special design, extra maintenance, or costly alteration.

Septic tank absorption fields are areas in which effluent from a septic tank is distributed into the soil through subsurface tiles or perforated pipe. Only that part of the soil between depths of 24 and 72 inches is evaluated. The ratings are based on soil properties, site features, and observed performance of the soils. Permeability, depth to bedrock, and flooding affect absorption of the effluent. Large stones and bedrock interfere with installation.

Unsatisfactory performance of septic tank absorption fields, including excessively slow absorption of effluent, surfacing of effluent, and hillside seepage, can affect public health. Ground water can be polluted if highly permeable sand and gravel or fractured bedrock is less than 4 feet below the base of the absorption field or if slope is excessive. There must be unsaturated soil material beneath the absorption field to effectively filter the effluent. Many local ordinances require that this material be of a certain thickness.

Sewage lagoons are shallow ponds constructed to hold sewage while aerobic bacteria decompose the solid and liquid wastes. Lagoons should have a nearly level floor surrounded by cut slopes or embankments of compacted soil. Lagoons generally are designed to hold the sewage within a depth of 2 to 5 feet. Nearly impervious soil material for the lagoon floor and sides is required to minimize seepage and contamination of ground water.

Table 11 gives ratings for the natural soil that makes up the lagoon floor. The surface layer and, generally, 1 or 2 feet of soil material below the surface layer are excavated to provide material for the embankments. The ratings are based on soil properties, site features, and observed performance of the soils. Considered in the ratings are slope, permeability, depth to bedrock, flooding, and large stones.

Excessive seepage due to rapid permeability of the soil or a water table that is high enough to raise the level of sewage in the lagoon causes a lagoon to function unsatisfactorily. Pollution results if seepage is excessive or if floodwater overtops the lagoon. Slope and bedrock can cause construction problems, and large stones can hinder compaction of the lagoon floor.

Sanitary landfills are areas where solid waste is disposed of by burying it in soil. There are two types of landfill—trench and area. In a trench landfill, the waste is placed in a trench. It is spread, compacted, and covered daily with a thin layer of soil excavated at the site. In an area landfill, the waste is placed in successive layers on the surface of the soil. The waste is spread, compacted, and covered daily with a thin layer of soil from a source away from the site.

Both types of landfill must be able to bear heavy vehicular traffic. Both types involve a risk of ground water pollution. Ease of excavation and revegetation needs to be considered.

The ratings in table 11 are based on soil properties, site features, and observed performance of the soils. Permeability, depth to bedrock, slope, and flooding affect both types of landfill. Texture, stones and boulders, and soil reaction affect trench type landfills. Unless otherwise stated, the ratings apply only to that part of the soil within a depth of about 6 feet. For deeper trenches, a limitation rated slight or moderate may not be valid. Onsite investigation is needed.

Daily cover for landfill is the soil material that is used to cover compacted solid waste in an area type sanitary landfill. The soil material is obtained offsite, transported to the landfill, and spread over the waste.

Soil texture, coarse fragments, and slope affect the ease of removing and spreading the material during wet and dry periods. Loamy or silty soils that are free of large stones or excess gravel are the best cover for a landfill. Clayey soils are sticky or cloddy and are difficult to spread; sandy soils are subject to soil blowing.

After soil material has been removed, the soil material remaining in the borrow area must be thick enough over bedrock to permit revegetation. The soil material used as final cover for a landfill should be suitable for plants. The surface layer generally has the best workability, more organic matter, and the best potential for plants. Material from the surface layer should be stockpiled for use as the final cover.

construction materials

Table 12 gives information about the soils as a source of roadfill, sand, gravel, and topsoil. The soils are rated *good, fair,* or *poor* as a source of roadfill and topsoil. They are rated as a probable or improbable source of sand and gravel. The ratings are based on soil properties and site features that affect the removal of the soil and its use as construction material. Normal compaction, minor processing, and other standard construction practices are assumed. Each soil is evaluated to a depth of 5 or 6 feet.

Roadfill is soil material that is excavated in one place and used in road embankments in another place. In this table, the soils are rated as a source of roadfill for low embankments, generally less than 6 feet high and less exacting in design than higher embankments.

The ratings are for the soil material below the surface layer to a depth of 5 or 6 feet. It is assumed that soil layers will be mixed during excavating and spreading. Many soils have layers of contrasting suitability within their profile. The table showing engineering index properties provides detailed information about each soil layer. This information can help determine the suitability of each layer for use as roadfill. The performance of soil after it is stabilized with lime or cement is not considered in the ratings.

The ratings are based on soil properties, site features, and observed performance of the soils. The thickness of suitable material is a major consideration. The ease of excavation is affected by large stones and slope. How well the soil performs in place after it has been

compacted and drained is determined by its strength (as inferred from the engineering classification of the soil) and shrink-swell potential.

Soils rated *good* contain significant amounts of sand or gravel or both. They have at least 5 feet of suitable material, low shrink-swell potential, few cobbles and stones, and slopes of 15 percent or less. Soils rated *fair* are more than 35 percent silt- and clay-sized particles and have a plasticity index of less than 10. They have moderate shrink-swell potential, slopes of 15 to 25 percent, or many stones. Soils rated *poor* have a plasticity index of more than 10, a high shrink-swell potential, many stones, or slopes of more than 25 percent. They may have layers of suitable material, but the material is less than 3 feet thick.

Sand and gravel are natural aggregates suitable for commercial use with a minimum of processing. Sand and gravel are used in many kinds of construction. Specifications for each use vary widely. In table 12, only the probability of finding material in suitable quantity is evaluated. The suitability of the material for specific purposes is not evaluated, nor are factors that affect excavation of the material.

The properties used to evaluate the soil as a source of sand or gravel are gradation of grain sizes (as indicated by the engineering classification of the soil), the thickness of suitable material, and the content of rock fragments. Kinds of rock and stratification are given in the soil series descriptions. Gradation of grain sizes is given in the table on engineering index properties.

A soil rated as a probable source has a layer of clean sand or gravel or a layer of sand or gravel that is up to 12 percent silty fines. This material must be at least 3 feet thick and less than 50 percent, by weight, large stones. All other soils are rated as an improbable source. Coarse fragments of soft bedrock, such as shale and siltstone, are not considered to be sand and gravel.

Topsoil is used to cover an area so that vegetation can be established and maintained. The upper 40 inches of a soil is evaluated for use as topsoil. Also evaluated is the reclamation potential of the borrow area.

Plant growth is affected by such properties as soil reaction, available water capacity, and fertility. The ease of excavating, loading, and spreading is affected by rock fragments, slope, soil texture, and thickness of suitable material. Reclamation of the borrow area is affected by slope, rock fragments, and bedrock.

Soils rated *good* have friable loamy material to a depth of at least 40 inches. They are free of stones and cobbles, have little or no gravel, and have slopes of less than 8 percent. They are naturally fertile or respond well to fertilizer and are not so wet that excavation is difficult.

Soils rated *fair* are sandy soils, loamy soils that have a relatively high content of clay, soils that have only 20 to 40 inches of suitable material, soils that have an appreciable amount of gravel or stones, or soils that have slopes of 8 to 15 percent. The soils are not so wet that excavation is difficult.

Soils rated *poor* are very sandy or clayey, have less than 20 inches of suitable material, have a large amount of gravel or stones, or have slopes of more than 15 percent.

The surface layer of most soils is generally preferred for topsoil because of its organic matter content. Organic matter greatly increases the absorption and retention of moisture and nutrients for plant growth.

water management

Table 13 gives information on the soil properties and site features that affect water management. The degree and kind of soil limitations are given for pond reservoir areas and embankments, dikes, and levees. The limitations are considered *slight* if soil properties and site features are generally favorable for the indicated use and limitations are minor and are easily overcome; *moderate* if soil properties or site features are not favorable for the indicated use and special planning, design, or maintenance is needed to overcome or minimize the limitations; and *severe* if soil properties or site features are so unfavorable or so difficult to overcome that special design, significant increase in construction costs, and possibly increased maintenance are required.

This table also gives for each soil the restrictive features that affect irrigation, terraces and diversions, and grassed waterways.

Pond reservoir areas hold water behind a dam or embankment. Soils best suited to this use have low seepage potential in the upper 60 inches. The seepage potential is determined by the permeability of the soil and the depth to fractured bedrock or other permeable material. Excessive slope can affect the storage capacity of the reservoir area.

Embankments, dikes, and levees are raised structures of soil material, generally less than 20 feet high, constructed to impound water or to protect land against overflow. In this table, the soils are rated as a source of material for embankment fill. The ratings apply to the soil material below the surface layer to a depth of about 5 feet. It is assumed that soil layers will be uniformly mixed and compacted during construction.

The ratings do not indicate the ability of the natural soil to support an embankment. Soil properties to a depth even greater than the height of the embankment can affect performance and safety of the embankment. Generally, deeper onsite investigation is needed to determine these properties.

Soil material in embankments must be resistant to seepage, piping, and erosion and must have favorable compaction characteristics. Unfavorable features include less than 5 feet of suitable material and a high content of stones or boulders.

Irrigation is the controlled application of water to supplement rainfall and support plant growth. The design

and management of an irrigation system are affected by flooding, available water capacity, intake rate, permeability, erosion hazard, and slope. The construction of a system is affected by large stones and depth to bedrock. The performance of a system is affected by the depth of the root zone and soil reaction.

Terraces and diversions are embankments or a combination of channels and ridges constructed across a slope to reduce erosion and conserve moisture by intercepting runoff. Slope, large stones, and depth to bedrock affect the construction of terraces and diversions. A restricted rooting depth, a severe hazard of wind or water erosion, an excessively coarse texture, and restricted permeability adversely affect maintenance.

Grassed waterways are natural or constructed channels, generally broad and shallow, that conduct surface water to outlets at a nonerosive velocity. Large stones, slope, and depth to bedrock affect the construction of grassed waterways. Low available water capacity, restricted rooting depth, and restricted permeability adversely affect the growth and maintenance of the grass after construction.

soil properties

Data relating to soil properties are collected during the course of the soil survey. The data and the estimates of soil and water features, listed in tables, are explained on the following pages.

Soil properties are determined by field examination of the soils and by laboratory index testing of some benchmark soils. Established standard procedures are followed. During the survey, many shallow borings are made and examined to identify and classify the soils and to delineate them on the soil maps. Samples are taken from some typical profiles and tested in the laboratory to determine grain-size distribution, plasticity, and compaction characteristics. These results are reported in table 17.

Estimates of soil properties are based on field examinations, on laboratory tests of samples from the survey area, and on laboratory tests of samples of similar soils in nearby areas. Tests verify field observations, verify properties that cannot be estimated accurately by field observation, and help characterize key soils.

The estimates of soil properties shown in the tables include the range of grain-size distribution and Atterberg limits, the engineering classifications, and the physical and chemical properties of the major layers of each soil. Pertinent soil and water features also are given.

engineering index properties

Table 14 gives estimates of the engineering classification and of the range of index properties for the major layers of each soil in the survey area. Most soils have layers of contrasting properties within the upper 5 or 6 feet.

Depth to the upper and lower boundaries of each layer is indicated. The range in depth and information on other properties of each layer are given for each soil series under "Soil series and their morphology."

Texture is given in the standard terms used by the U.S. Department of Agriculture. These terms are defined according to percentages of sand, silt, and clay in the fraction of the soil that is less than 2 millimeters in diameter. "Loam," for example, is soil that is 7 to 27 percent clay, 28 to 50 percent silt, and less than 52 percent sand. If a soil contains particles coarser than sand, an appropriate modifier is added, for example, "gravelly." Textural terms are defined in the Glossary.

Classification of the soils is determined according to the Unified soil classification system (*2*) and the system adopted by the American Association of State Highway and Transportation Officials (*1*).

The Unified system classifies soils according to properties that affect their use as construction material. Soils are classified according to grain-size distribution of the fraction less than 3 inches in diameter and according to plasticity index, liquid limit, and organic matter content. Sandy and gravelly soils are identified as GW, GP, GM, GC, SW, SP, SM, and SC; silty and clayey soils as ML, CL, OL, MH, CH, and OH; and highly organic soils as Pt. Soils exhibiting engineering properties of two groups can have a dual classification, for example, SP-SM.

The AASHTO system classifies soils according to those properties that affect roadway construction and maintenance. In this system, the fraction of a mineral soil that is less than 3 inches in diameter is classified in one of seven groups from A-1 through A-7 on the basis of grain-size distribution, liquid limit, and plasticity index. Soils in group A-1 are coarse grained and low in content of fines (silt and clay). At the other extreme, soils in group A-7 are fine grained. Highly organic soils are classified in group A-8 on the basis of visual inspection.

If laboratory data are available, the A-1, A-2, and A-7 groups are further classified as A-1-a, A-1-b, A-2-4, A-2-5, A-2-6, A-2-7, A-7-5, or A-7-6. As an additional refinement, the suitability of a soil as subgrade material can be indicated by a group index number. Group index numbers range from 0 for the best subgrade material to 20 or higher for the poorest. The AASHTO classification for soils tested, with group index numbers in parentheses, is given in table 17.

Rock fragments larger than 3 inches in diameter are indicated as a percentage of the total soil on a dry-weight basis. The percentages are estimates determined mainly by converting volume percentage in the field to weight percentage.

Percentage (of soil particles) passing designated sieves is the percentage of the soil fraction less than 3 inches in diameter based on an oven-dry weight. The sieves, numbers 4, 10, 40, and 200 (USA Standard Series), have openings of 4.76, 2.00, 0.420, and 0.074 millimeters, respectively. Estimates are based on laboratory tests of soils sampled in the survey area and in nearby areas and on estimates made in the field.

Liquid limit and *plasticity index* (Atterberg limits) indicate the plasticity characteristics of a soil. The estimates are based on test data from the survey area or from nearby areas and on field examination.

The estimates of grain-size distribution, liquid limit, and plasticity index are rounded to the nearest 5 percent. Thus, if the ranges of gradation and Atterberg limits extend a marginal amount (1 or 2 percentage points) across classification boundaries, the classification in the marginal zone is omitted in the table.

physical and chemical properties

Table 15 shows estimates of some characteristics and features that affect soil behavior. These estimates are given for the major layers of each soil in the survey area. The estimates are based on field observations and on test data for these and similar soils.

Clay as a soil separate consists of mineral soil particles that are less than 0.002 millimeter in diameter. In this table, the estimated clay content of each major soil layer is given as a percentage, by weight, of the soil material that is less than 2 millimeters in diameter.

The amount and kind of clay greatly affect the fertility and physical condition of the soil. They determine the ability of the soil to adsorb cations and to retain moisture. They influence shrink-swell potential, permeability, and plasticity, the ease of soil dispersion, and other soil properties. The amount and kind of clay in a soil also affect tillage and earth-moving operations.

Permeability refers to the ability of a soil to transmit water or air. The estimates indicate the rate of downward movement of water when the soil is saturated. They are based on soil characteristics observed in the field, particularly structure, porosity, and texture. Permeability is considered in the design of soil drainage systems, septic tank absorption fields, and construction where the rate of water movement under saturated conditions affects behavior.

Available water capacity refers to the quantity of water that the soil is capable of storing for use by plants. The capacity for water storage is given in inches of water per inch of soil for each major soil layer. The capacity varies, depending on soil properties that affect the retention of water and the depth of the root zone. The most important properties are the content of organic matter, soil texture, bulk density, and soil structure. Available water capacity is an important factor in the choice of plants or crops to be grown and in the design and management of irrigation systems. Available water capacity is not an estimate of the quantity of water actually available to plants at any given time.

Soil reaction is a measure of acidity or alkalinity and is expressed as a range in pH values. The range in pH of each major horizon is based on many field tests. For many soils, values have been verified by laboratory analyses. Soil reaction is important in selecting crops and other plants, in evaluating soil amendments for fertility and stabilization, and in determining the risk of corrosion.

Shrink-swell potential is the potential for volume change in a soil with a loss or gain in moisture. Volume change occurs mainly because of the interaction of clay minerals with water and varies with the amount and type of clay minerals in the soil. The size of the load on the soil and the magnitude of the change in soil moisture content influence the amount of swelling of soils in place. Laboratory measurements of swelling of undisturbed clods were made for many soils. For others, swelling was estimated on the basis of the kind and amount of clay minerals in the soil and on measurements of similar soils.

If the shrink-swell potential is rated moderate to very high, shrinking and swelling can cause damage to buildings, roads, and other structures. Special design is often needed.

Shrink-swell potential classes are based on the change in length of an unconfined clod as moisture content is increased from air-dry to field capacity. The change is based on the soil fraction less than 2 millimeters in diameter. The classes are *low*, a change of less than 3 percent; *moderate*, 3 to 6 percent; and *high*, more than 6 percent. *Very high*, greater than 9 percent, is sometimes used.

Erosion factor K indicates the susceptibility of a soil to sheet and rill erosion by water. Factor K is one of six factors used in the Universal Soil Loss Equation (USLE) to predict the average annual rate of soil loss by sheet and rill erosion in tons per acre per year. The estimates are based primarily on percentage of silt, sand, and organic matter (up to 4 percent) and on soil structure and permeability. Values of K range from 0.05 to 0.69. The higher the value the more susceptible the soil is to sheet and rill erosion by water.

Erosion factor T is an estimate of the maximum average annual rate of soil erosion by wind or water that can occur without affecting crop productivity over a sustained period. The rate is in tons per acre per year.

In table 15, the estimated content of organic matter of the plow layer is expressed as a percentage, by weight, of the soil material that is less than 2 millimeters in diameter.

The content of organic matter of a soil can be maintained or increased by returning crop residue to the soil. Organic matter affects the available water capacity, infiltration rate, and tilth. It is a source of nitrogen and other nutrients for crops.

soil and water features

Table 16 gives estimates of various soil and water features. The estimates are used in land use planning that involves engineering considerations.

Hydrologic soil groups are used to estimate runoff from precipitation. Soils not protected by vegetation are assigned to one of four groups. They are grouped according to the intake of water when the soils are thoroughly wet and receive precipitation from long-duration storms.

The four hydrologic soil groups are:

Group A. Soils having a high infiltration rate (low runoff potential) when thoroughly wet. These consist mainly of deep, well drained to excessively drained sands or gravelly sands. These soils have a high rate of water transmission.

Group B. Soils having a moderate infiltration rate when thoroughly wet. These consist chiefly of moderately deep or deep, moderately well drained or well drained soils that have moderately fine texture to moderately coarse texture. These soils have a moderate rate of water transmission.

Group C. Soils having a slow infiltration rate when thoroughly wet. These consist chiefly of soils having a layer that impedes the downward movement of water or soils of moderately fine texture or fine texture. These soils have a slow rate of water transmission.

Group D. Soils having a very slow infiltration rate (high runoff potential) when thoroughly wet. These consist chiefly of clays that have a high shrink-swell potential, soils that have a permanent high water table, soils that have a claypan or clay layer at or near the surface, and soils that are shallow over nearly impervious material. These soils have a very slow rate of water transmission.

Flooding, the temporary inundation of an area, is caused by overflowing streams, by runoff from adjacent slopes, or by tides. Water standing for short periods after rainfall or snowmelt and water in swamps and marshes are not considered flooding.

Table 16 gives the frequency and duration of flooding and the time of year when flooding is most likely.

Frequency, duration, and probable dates of occurrence are estimated. Frequency is expressed as none, rare, common, occasional, and frequent. *None* means that flooding is not probable; *rare* that it is unlikely but possible under unusual weather conditions; *common* that it is likely under normal conditions; *occasional* that it occurs on an average of once or less in 2 years; and *frequent* that it occurs on an average of more than once in 2 years. Duration is expressed as *very brief* if less than 2 days, *brief* if 2 to 7 days, and *long* if more than 7 days. Probable dates are expressed in months; November-May, for example, means that flooding can occur during the period November through May.

The information is based on evidence in the soil profile, namely thin strata of gravel, sand, silt, or clay deposited by floodwater; irregular decrease in organic matter content with increasing depth; and absence of distinctive horizons that form in soils that are not subject to flooding.

Also considered are local information about the extent and levels of flooding and the relation of each soil on the landscape to historic floods. Information on the extent of flooding based on soil data is less specific than that provided by detailed engineering surveys that delineate flood-prone areas at specific flood frequency levels.

High water table (seasonal) is the highest level of a saturated zone in the soil in most years. The depth to the seasonal high water table is more than 6 feet in all of the soils in Kendall County.

Depth to bedrock is given if bedrock is within a depth of 5 feet. The depth is based on many soil borings and on observations during soil mapping. The rock is specified as either soft or hard. If the rock is soft or fractured, excavations can be made with trenching machines, backhoes, or small rippers. If the rock is hard or massive, blasting or special equipment generally is needed for excavation.

Risk of corrosion pertains to potential soil-induced electrochemical or chemical action that dissolves or weakens uncoated steel or concrete. The rate of corrosion of uncoated steel is related to such factors as soil moisture, particle-size distribution, acidity, and electrical conductivity of the soil. The rate of corrosion of concrete is based mainly on the sulfate and sodium content, texture, moisture content, and acidity of the soil. Special site examination and design may be needed if the combination of factors creates a severe corrosion environment. The steel in installations that intersect soil boundaries or soil layers is more susceptible to corrosion than steel in installations that are entirely within one kind of soil or within one soil layer.

For uncoated steel, the risk of corrosion, expressed as *low*, *moderate*, or *high*, is based on soil drainage class, total acidity, electrical resistivity near field capacity, and electrical conductivity of the saturation extract.

For concrete, the risk of corrosion is also expressed as *low*, *moderate*, or *high*. It is based on soil texture, acidity, and amount of sulfates in the saturation extract.

engineering index test data

Table 17 shows laboratory test data for several pedons sampled at carefully selected sites in the survey area. The pedons are typical of the series and are described in the section "Soil series and their morphology." The soil samples were tested by Texas Department of Highways and Public Transportation.

The testing methods generally are those of the American Association of State Highway and Transportation Officials (AASHTO) or the American Society for Testing and Materials (ASTM).

The tests and methods are: AASHTO classification—M 145 (AASHTO), D 3282 (ASTM); Unified classification—D 2487 (ASTM); Mechanical analysis—T 88 (AASHTO), D 2217 (ASTM); Liquid limit—T 89 (AASHTO), D 423 (ASTM); Plasticity index—T 90 (AASHTO), D 424 (ASTM); Moisture density, Method A—T 99 (AASHTO), D 698 (ASTM); Shrinkage—T 92 (AASHTO), D 427 (ASTM).

classification of the soils

The system of soil classification used by the National Cooperative Soil Survey has six categories (*5*). Beginning with the broadest, these categories are the order, suborder, great group, subgroup, family, and series. Classification is based on soil properties observed in the field or inferred from those observations or from laboratory measurements. In table 18, the soils of the survey area are classified according to the system. The categories are defined in the following paragraphs.

ORDER. Ten soil orders are recognized. The differences among orders reflect the dominant soil-forming processes and the degree of soil formation. Each order is identified by a word ending in *sol*. An example is Entisol.

SUBORDER. Each order is divided into suborders primarily on the basis of properties that influence soil genesis and are important to plant growth or properties that reflect the most important variables within the orders. The last syllable in the name of a suborder indicates the order. An example is Aquent (*Aqu*, meaning water, plus *ent*, from Entisol).

GREAT GROUP. Each suborder is divided into great groups on the basis of close similarities in kind, arrangement, and degree of development of pedogenic horizons; soil moisture and temperature regimes; and base status. Each great group is identified by the name of a suborder and by a prefix that indicates a property of the soil. An example is Haplaquents (*Hapl*, meaning minimal horizonation, plus *aquent*, the suborder of the Entisols that have an aquic moisture regime).

SUBGROUP. Each great group has a typic subgroup. Other subgroups are intergrades or extragrades. The typic is the central concept of the great group; it is not necessarily the most extensive. Intergrades are transitions to other orders, suborders, or great groups. Extragrades have some properties that are not representative of the great group but do not indicate transitions to any other known kind of soil. Each subgroup is identified by one or more adjectives preceding the name of the great group. The adjective *Typic* identifies the subgroup that typifies the great group. An example is Typic Haplaquents.

FAMILY. Families are established within a subgroup on the basis of physical and chemical properties and other characteristics that affect management. Mostly the properties are those of horizons below plow depth where there is much biological activity. Among the properties and characteristics considered are particle-size class, mineral content, temperature regime, depth of the root zone, consistence, moisture equivalent, slope, and permanent cracks. A family name consists of the name of a subgroup preceded by terms that indicate soil properties. An example is fine-loamy, carbonatic, thermic Cumulic Haplustolls.

SERIES. The series consists of soils that have similar horizons in their profile. The horizons are similar in color, texture, structure, reaction, consistence, mineral and chemical composition, and arrangement in the profile. The texture of the surface layer or of the substratum can differ within a series.

soil series and their morphology

In this section, each soil series recognized in the survey area is described. The descriptions are arranged in alphabetic order.

Characteristics of the soil and the material in which it formed are identified for each series. A pedon, a small three-dimensional area of soil, that is typical of the series in the survey area is described. The detailed description of each soil horizon follows standards in the Soil Survey Manual (*4*). Many of the technical terms used in the descriptions are defined in Soil Taxonomy (*5*). Unless otherwise stated, colors in the descriptions are for dry soil. Following the pedon description is the range of important characteristics of the soils in the series.

Figure 13 shows the general pattern of the soils and underlying material in Kendall County. The soils formed from limestone, limestone and marl, alluvium, and alluvial sediments.

The map units of each soil series are described in the section "Detailed soil map units."

Anhalt series

The Anhalt series consists of gently sloping, moderately deep, well drained, clayey soils that formed in residuum from the weathering of limestone. These soils are on uplands. Slopes range from 1 to 3 percent (see fig. 1).

A typical pedon of Anhalt clay, 1 to 3 percent slopes, at the center of a microknoll, from the city hall in Boerne, east 0.9 mile to the junction of an improved road and Farm Road 474, south 200 feet on improved road, and 70 feet east from centerline of road, in rangeland:

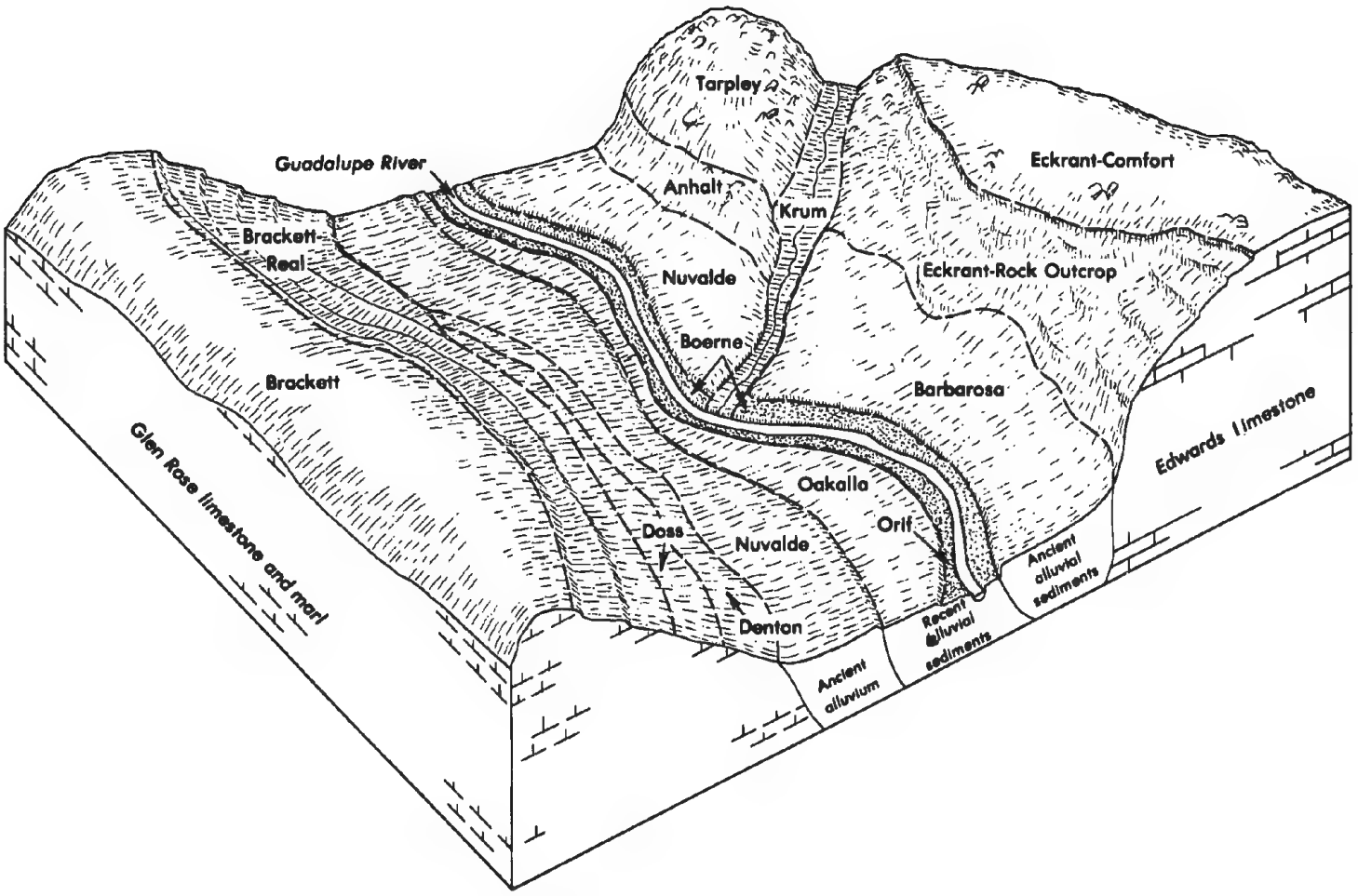

Figure 13.—Typical pattern of soils and underlying material in Kendall County.

A1—0 to 7 inches; dark brown (7.5YR 3/2) clay, very dark brown (7.5YR 2/2) moist; strong fine and medium blocky structure; very hard, very firm, very sticky and plastic; common roots; few chert gravel-size fragments up to 1 inch in diameter; cracks up to 1 inch wide when dry; neutral; clear wavy boundary.

B21—7 to 23 inches; dark reddish brown (2.5YR 3/4) clay, dark reddish brown (2.5YR 3/4) moist; strong medium blocky structure; very hard, very firm, very sticky and plastic; common roots; few small chert particles; common intersecting slickensides and wedge-shaped peds; slightly acid; gradual wavy boundary.

B22—23 to 29 inches; dark reddish brown (2.5YR 3/4) clay, dark reddish brown (2.5YR 3/4) moist; moderate fine subangular blocky structure; very hard, very firm, sticky and plastic; few roots; few limestone particles; calcareous; mildly alkaline; abrupt wavy boundary.

R—29 to 30 inches; indurated, fractured limestone.

Thickness of the solum ranges from 20 to 40 inches over indurated limestone bedrock or limestone interbedded with clayey marl. Limestone and chert fragments comprise up to 20 percent of the soil mass and cover as much as 20 percent of the surface. When dry, the soil has cracks that range from 0.4 to 2.0 inches in width from the surface to the limestone bedrock. Slickensides are below a depth of 15 inches. Clay content ranges from 60 to 80 percent.

The A horizon is dark reddish brown, reddish brown, or dark brown. Reaction ranges from slightly acid to mildly alkaline.

The B2 horizon is dark reddish brown or reddish brown. Reaction ranges from slightly acid to mildly alkaline. Some pedons have segregated lime at the contact of the limestone bedrock.

Barbarosa series

The Barbarosa series consists of nearly level, deep, well drained, loamy soils that formed in calcareous,

loamy sediment. These soils are on nearly level, ancient stream terraces. Slopes are dominantly less than 1 percent.

A typical pedon of Barbarosa silty clay loam, 0 to 1 percent slopes, from the town of Waring, 1.2 miles northeast on an improved county road paralleling the south bank of the Guadalupe River, south 0.25 mile to the entrance of a cultivated field, and west 300 feet:

Ap—0 to 6 inches; dark brown (7.5YR 4/2) silty clay loam, dark brown (7.5YR 3/2) moist; moderate medium subangular blocky structure parting to moderate fine granular; very hard, very firm; cracks 2 to 5 millimeters wide; common fine roots; noncalcareous; mildly alkaline; abrupt smooth boundary.

A11—6 to 11 inches; dark brown (7.5YR 4/2) silty clay loam, dark brown (7.5YR 3/2) moist; moderate medium subangular blocky structure parting to moderate fine granular; very hard, very firm; few cracks 2 to 5 millimeters wide; few fine roots; few discontinuous pores; noncalcareous; mildly alkaline; clear smooth boundary.

B21t—11 to 23 inches; reddish brown (5YR 4/4) clay, dark reddish brown (5YR 3/4) moist; moderate medium angular blocky structure; very hard, very firm; darker soil in vertical veins 5 to 8 millimeters wide; few fine and medium roots; few fine irregular pores, common clay films on peds; calcareous; moderately alkaline; gradual smooth boundary.

B22tca—23 to 29 inches; yellowish red (5YR 5/6) clay, yellowish red (5YR 4/6) moist; moderate medium angular blocky structure; very hard, very firm; few clay films on peds; few fine soft bodies and threads of calcium carbonate; calcareous; moderately alkaline; gradual smooth boundary.

B23tca—29 to 48 inches; yellowish red (5YR 5/6) clay, yellowish red (5YR 4/6) moist; moderate fine subangular blocky structure; hard, firm; few clay films on peds; estimated 25 percent by volume cemented concretions and soft threads of calcium carbonate; calcareous; moderately alkaline; diffuse wavy boundary.

B24tca—48 to 63 inches; yellowish red (5YR 5/6) clay, yellowish red (5YR 4/6) moist; weak fine subangular blocky structure; hard, firm; few clay films; estimated 10 percent by volume cemented calcium carbonate concretions and 10 percent by volume soft bodies and threads of calcium carbonate; calcareous; moderately alkaline.

Thickness of the solum ranges from 60 to more than 72 inches. The A horizon is dark brown or dark grayish brown. The B2t horizon is reddish yellow, reddish brown, or brown. The B24tca horizon is reddish yellow or yellowish red.

Boerne series

The Boerne series consists of gently sloping and gently undulating, deep, well drained, loamy soils that formed in loamy sediment. These soils are on stream terraces and flood plains derived from soft limestone and marl. Slopes range from 1 to 3 percent.

Typical pedon of Boerne fine sandy loam, from the intersection of Ranch Road 473 and Ranch Road 1376 (south of Sisterdale), 0.9 mile south and 100 feet east in idle cropland:

Ap—0 to 8 inches; grayish brown (10YR 5/2) fine sandy loam, dark grayish brown (10YR 4/2) moist; weak medium subangular blocky structure; slightly hard, friable, slightly sticky; common fine and medium roots; common fine and medium tubes and pores; horizontal lenses of small limestone pebbles; few insect burrows; few fine cemented bodies of calcium carbonate; calcareous; moderately alkaline; abrupt smooth boundary.

B2—8 to 46 inches; pale brown (10YR 6/3) loam, brown (10YR 5/3) moist; weak medium subangular blocky structure parting to weak fine granular; slightly hard, friable, slightly sticky; common fine and few medium roots; many fine and medium tubes and pores; many insect burrows and casts; few horizontal discontinuous lenses of round calcareous pebbles 1/2 to 1 inch in diameter; calcareous; moderately alkaline; gradual smooth boundary.

Cca—46 to 60 inches; light yellowish brown (10YR 6/4) loam, dark yellowish brown (10YR 4/4) moist; massive; hard, friable, sticky; many fine threads and soft bodies of calcium carbonate; calcareous; moderately alkaline.

Thickness of the solum ranges from 36 to 80 inches. The calcium carbonate equivalent ranges from 45 to 60 percent. The soil has 12 to 18 percent silicate clay. Rounded and waterworn limestone fragments, 3 to 15 millimeters in diameter, range from 1 to 5 percent by volume. They are in a discontinuous horizontal wavy line that is 1 to 3 inches thick.

The A horizon is grayish brown, brown, light brownish gray, or yellowish brown loam or fine sandy loam. The B horizon is pale brown, light yellowish brown, or pinkish gray loam or fine sandy loam.

Brackett series

The Brackett series consists of undulating and hilly, shallow, well drained, loamy soils that formed in material weathered from interbedded, soft limestone and marly earth. The sequence of the more resistant layers of limestone and softer strata of marl results in a stairstep, or benched, appearance. Brackett soils are on uplands. Slopes range from 1 to 30 percent (see fig. 2).

A typical pedon of Brackett gravelly clay loam, in an area of Brackett-Real association, hilly, from the intersection of U.S. Highway 87 and Interstate Highway 10 north of Boerne, northwest 1 mile, west 2.7 miles on Upper Cibolo Creek road, south 1 mile on a paved subdivision road, and west 50 feet, in rangeland:

A1—0 to 6 inches; light brownish gray (10YR 6/2) gravelly clay loam, dark grayish brown (10YR 4/2) moist; moderate fine subangular blocky structure parting to moderate fine granular; hard, firm, sticky; common fine roots; 15 percent by volume small, rounded, and weakly cemented limestone fragments; 51 percent calcium carbonate equivalent; calcareous; moderately alkaline; clear wavy boundary.

B2—6 to 14 inches; light brownish gray (2.5Y 6/2) clay loam, grayish brown (2.5Y 5/2) moist; moderate medium subangular blocky structure parting to moderate fine granular; hard, firm; few fine roots; common fine pores; many soft masses calcium carbonate; 10 percent by volume pebble-size limestone fragments; 60 percent calcium carbonate equivalent; calcareous; moderately alkaline; clear wavy boundary.

Cr—14 to 30 inches; weakly cemented limestone interbedded with white marl that contains soft, vertically elongated soft masses of calcium carbonate.

Thickness of the solum ranges from 10 to 19 inches. Content of coarse fragments ranges from a few pebble-size limestone fragments to 25 percent by volume. The calcium carbonate equivalent ranges from 50 to 75 percent. Texture is gravelly loam, gravelly clay loam, or their nongravelly counterparts. Clay content ranges from 20 to 34 percent.

The A horizon is very pale brown, pale brown, brown, light yellowish brown, or light brownish gray. The B2 horizon is light yellowish brown, very pale brown, pale brown, yellowish brown, or light brownish gray. The Cr horizon is pale yellow, olive yellow, light brownish gray, or white.

Comfort series

The Comfort series consists of gently undulating, shallow, well drained, clayey and stony soils that formed in clayey sediment over crystalline limestone of the Lower Cretaceous Period. These soils are on upland plateaus. Slopes dominantly range from 1 to 5 percent (see fig. 8).

A typical pedon of Comfort stony clay in an area of Eckrant-Comfort association, gently undulating, from the intersection of Ranch Road 474 and U.S. Highway 87 in Boerne, northwest on U.S. Highway 87 to west access road of Interstate Highway 10, northwest 1.1 miles to Cibolo Creek road, west approximately 3 miles to entrance to a subdivision, south on a paved road 1.3 miles, and west 0.3 mile, on top of a ridge in rangeland:

A—0 to 5 inches; dark grayish brown (10YR 4/2) stony clay, very dark grayish brown (10YR 3/2) moist; moderate medium angular blocky structure parting to moderate fine subangular; very hard, very firm; many fine grass roots; few very fine tubular pores; estimated 15 percent by volume angular limestone pebbles; 40 percent by volume pebbles and stones partially on the surface and in the soil; noncalcareous; mildly alkaline; clear wavy boundary.

B2t—5 to 17 inches; dark reddish gray (5YR 4/2) stony clay, dark reddish brown (5YR 3/2) moist; moderate strong medium subangular and angular blocky structure parting to moderately strong fine angular blocky; very hard, very firm; few fine and medium roots; estimated 40 percent by volume cobble- and stone-size angular limestone fragments; many roots at soil-rock interfaces; mildly alkaline; abrupt wavy boundary.

R—17 to 20 inches; indurated crystalline limestone; about 3 percent by volume irregular veins filled with soil.

Thickness of the solum and the depth to limestone bedrock range from 9 to 20 inches. Reaction ranges from neutral to moderately alkaline. Coarse fragments of stone, cobble, and pebble size cover 35 to 60 percent of the surface and make up 35 to 60 percent of the soil. Coarser fragments are crystalline dolomitic limestone, and the pebbles are dominantly chert.

The A horizon is dark grayish brown, very dark grayish brown, dark brown, dark reddish gray, or dark reddish brown. The fine earth fraction is clay or clay loam. The B2t horizon is red, reddish brown, dark reddish brown, dark reddish gray, or dark brown. The fine earth fraction is clay, and clay content ranges from 55 to about 75 percent.

Denton series

The Denton series consists of gently sloping, moderately deep, well drained, clayey soils that formed in clayey sediment over fractured limestone and marl. These soils are on uplands. Slopes range from 1 to 5 percent (see fig. 4).

A typical pedon of Denton silty clay, 1 to 3 percent slopes, from the intersection of U. S. Highway 87 and Texas Highway 46 in Boerne, east 2.6 miles to Ammon Road, 2.2 miles east on Ammon Road, and north 0.2 mile, in rangeland:

A11—0 to 11 inches; very dark grayish brown (10YR 3/2) silty clay, very dark brown (10YR 2/2) moist; moderate medium subangular blocky structure parting to moderate fine subangular blocky; very hard, very firm; common fine and medium grass roots; few very fine calcium carbonate fragments;

calcareous; moderately alkaline; clear smooth boundary.
A12—11 to 24 inches; dark grayish brown (10YR 4/2) silty clay, very dark grayish brown (10YR 3/2) moist; moderate medium subangular blocky structure; very hard, very firm; few fine grass roots; few very fine cemented bodies of calcium carbonate; 18 percent calcium carbonate equivalent; calcareous; moderately alkaline; clear smooth boundary.
B2ca—24 to 34 inches; brown (7.5YR 5/4) clay, brown (7.5YR 4/4) moist; weak fine subangular blocky structure; hard, firm; estimated 30 percent by volume visible threads and fine weakly cemented bodies of calcium carbonate; 47 percent calcium carbonate equivalent; calcareous; moderately alkaline; gradual smooth boundary.
B3ca—34 to 39 inches; brown (7.5YR 5/4) clay; brown (7.5YR 4/4) moist; weak fine subangular blocky structure; hard, firm; estimated 45 percent by volume threads, soft bodies, and weakly cemented fragments of calcium carbonate; 60 percent calcium carbonate equivalent; calcareous; moderately alkaline; abrupt smooth boundary.
R—39 to 41 inches; cemented limestone in upper 1 inch, interbedded calcareous marl below.

Thickness of the solum over limestone or marl ranges from 24 to 39 inches. The A horizon is dark grayish brown, very dark grayish brown, very dark brown, or brown. The B horizon is brown, yellowish brown, or dark brown silty clay or clay.

Doss series

The Doss series consists of gently sloping and undulating, shallow, well drained, clayey soils that formed in calcareous marl and weakly cemented limestone. These soils are on uplands. Slopes range from 1 to 8 percent (see fig. 5).

A typical pedon of Doss silty clay, 1 to 5 percent slopes, 2.6 miles east from the intersection of U.S. Highway 87 and Texas Highway 46 in Boerne, 2 miles east on Ammon Road to a gate, 0.35 mile farther east, and 50 feet south:

A1—0 to 9 inches; dark grayish brown (10YR 4/2) silty clay, very dark grayish brown (10YR 3/2) moist; moderate medium subangular blocky structure parting to moderate fine subangular blocky; hard, firm; common fine and medium grass roots; few fine irregular pores; common fine and medium soft and weakly cemented calcium carbonate fragments; 29 percent calcium carbonate equivalent; calcareous; moderately alkaline; clear smooth boundary.
B2ca—9 to 18 inches; brown (7.5YR 5/4) silty clay, dark brown (7.5YR 4/4) moist; moderate medium subangular blocky structure parting to moderate fine subangular blocky; hard, firm; common fine roots; few common fine and medium calcium carbonate concretions; common fine threads and soft bodies of calcium carbonate; 47 percent calcium carbonate equivalent; calcareous; moderately alkaline; clear smooth boundary.
Crca—18 to 30 inches; marl and weakly cemented caliche in 1/2-inch, thin, discontinuous strata.

Thickness of the solum to marl and weakly cemented caliche ranges from 13 to 19 inches. The soil contains from 3 to 10 percent coarse fragments. In places the surface has a 5 to 15 percent cover of pebble-size coarse fragments. The calcium carbonate equivalent ranges from 41 to 54 percent.

The A horizon is dark grayish brown, very dark grayish brown, or dark brown. The B horizon is brown or reddish brown silty clay or clay loam. The Crca horizon is pink, very pale brown, or light yellowish brown. It is weakly cemented limy earth that is clay loam, weakly cemented limestone, caliche, or marl. Most pedons contain interbedded fractured limestone and marl in the Crca horizon.

Eckrant series

The Eckrant series consists of gently undulating to steep, shallow and very shallow, well drained, stony and clayey soils on uplands. These soils formed from limestone. Slopes range from 1 to 30 percent and are convex (see fig. 7).

Typical pedon of Eckrant stony clay, in an area of Eckrant-Comfort association, gently undulating, from Interstate Highway 10, 1.3 miles west on Cibolo Creek road, south 0.6 mile on a paved road, and west 0.3 mile, on top of a ridge in rangeland:

A1—0 to 5 inches; very dark gray (10YR 3/1) stony clay, black (10YR 2/1) moist; moderate medium subangular blocky structure; very hard, very firm; common fine roots; estimated 45 percent by volume angular limestone fragments of stone and cobble size; 15 percent by volume angular limestone pebbles; mildly alkaline; abrupt wavy boundary.
R—5 to 7 inches; indurated limestone bedrock.

Thickness of the solum ranges from 4 to 14 inches. Angular limestone pebbles, cobbles, and stones make up from 40 to 65 percent by volume of the soil. Reaction ranges from neutral to moderately alkaline. Some pedons are calcareous. The A horizon is very dark gray, black, dark grayish brown, very dark grayish brown, or dark brown.

Krum series

The Krum series consists of gently sloping, deep, well drained, clayey soils that formed in thick beds of calcareous, clayey sediment in filled valleys. Slopes range from 1 to 5 percent.

A typical pedon of Krum silty clay, 3 to 5 percent slopes, from the intersection of Ranch Road 473 and Ranch Road 1376 in Sisterdale, 4.5 miles north, and east 3.1 miles on a private ranch road:

A1—0 to 16 inches; dark grayish brown (10YR 4/2) silty clay, very dark grayish brown (10YR 3/2) moist; moderate fine subangular blocky structure parting to moderate fine granular; hard, firm; many fine and common medium grass roots; many very fine fragments of calcium carbonate; calcareous; moderately alkaline; clear smooth boundary.

B2—16 to 42 inches; brown (10YR 5/3) silty clay, dark brown (10YR 4/3) moist; moderate fine subangular blocky structure parting to moderate fine granular; hard, firm; darker soil from the A1 horizon in vertical filled cracks; few fine and medium concretions of calcium carbonate; few fine roots; calcareous; moderately alkaline; clear smooth boundary.

B3ca—42 to 47 inches; light yellowish brown (10YR 6/4) silty clay, yellowish brown (10YR 5/4) moist; weak fine subangular blocky structure; hard, firm; estimated 15 percent by volume soft bodies of calcium carbonate; calcareous; moderately alkaline; diffuse smooth boundary.

C—47 to 60 inches; light yellowish brown (10YR 6/4) clay loam, yellowish brown (10YR 5/4) moist; massive; hard, firm; estimated 20 percent by volume angular limestone fragments 1/8 to 1/2 inch in diameter; calcareous; moderately alkaline.

Thickness of the solum is 40 to 56 inches. Depth to the calcic horizon is 40 to 52 inches. COLE ranges from 0.07 to about 0.2 in the upper 40 inches.

The A horizon is dark gray, dark grayish brown, very dark grayish brown, brown, or dark brown. The B horizon is grayish brown, brown, or yellowish brown silty clay or clay. The C horizon is pale brown, light brown, or light yellowish brown clay loam, silty clay, or silty clay loam. Segregated calcium carbonate ranges from 5 to 20 percent by volume.

Nuvalde series

The Nuvalde series consists of nearly level to gently sloping, deep, well drained, clayey soils that formed in ancient alluvium on stream terraces. Slopes range from 0 to 3 percent.

Typical pedon of Nuvalde silty clay, 1 to 3 percent slopes, from the intersection of U.S. Highway 87 and Ranch Road 473 in Comfort, 2.9 miles east on Ranch Road 473, south through a field gate, and east 0.4 mile, in an improved pasture:

Ap—0 to 6 inches; dark grayish brown (10YR 4/2) silty clay, very dark grayish brown (10YR 3/2) moist; weak medium subangular blocky structure; hard, firm; common fine grass roots; few very fine calcium carbonate fragments; calcareous; moderately alkaline; abrupt smooth boundary.

A1—6 to 11 inches; dark grayish brown (10YR 4/2) silty clay, very dark grayish brown (10YR 3/2) moist; moderate medium subangular blocky structure; hard, firm; common fine grass roots; few very fine calcium carbonate fragments; calcareous; moderately alkaline; gradual smooth boundary.

B21ca—11 to 26 inches; reddish brown (5YR 4/3) clay, dark reddish brown (5YR 3/3) moist; moderate medium subangular blocky structure; hard, firm; few fine grass roots; estimated 2 percent by volume concretions and soft bodies of calcium carbonate; calcareous; moderately alkaline; gradual smooth boundary.

B22ca—26 to 37 inches; reddish brown (5YR 4/4) clay, dark reddish brown (5YR 3/4) moist; weak fine subangular blocky structure; hard, firm; few medium grass roots; estimated 5 percent by volume small rounded and angular limestone fragments; soft bodies and threads of calcium carbonate; calcareous; moderately alkaline; gradual smooth boundary.

B23ca—37 to 44 inches; reddish brown (5YR 4/4) clay, dark reddish brown (5YR 3/4) moist; weak fine subangular blocky structure; hard, firm; estimated 25 percent by volume weakly cemented and soft bodies of calcium carbonate; 65 percent calcium carbonate equivalent; calcareous; moderately alkaline; diffuse smooth boundary.

Cca—44 to 63 inches; yellowish red (5YR 5/6) clay loam, yellowish red (5YR 4/6) moist; massive; hard, firm; estimated 20 percent by volume threads and soft masses of calcium carbonate; 41 percent calcium carbonate equivalent; calcareous; moderately alkaline.

Thickness of the solum ranges from 30 to 64 inches. The calcium carbonate equivalent of the 10- to 40-inch control section ranges from 23 to 38 percent.

The A horizon is dark brown, brown, grayish brown, or dark grayish brown. The B horizon is reddish yellow, reddish brown, dark reddish brown, pink, yellowish red, brown, light brown, light yellowish brown, or yellowish brown clay or silty clay. It contains an estimated 5 to 25 percent visible carbonates. Depth to gravel ranges from 3 to more than 8 feet. The C horizon is clay loam, clay, or silty clay.

These soils have a thicker solum than is typical for the Nuvalde series and are considered as taxadjuncts. Use, management, and behavior, however, are similar.

Oakalla series

The Oakalla series consists of nearly level to gently sloping, deep, well drained, loamy soils that formed in alluvium. These soils are on flood plains and subject to

overflow from streams after periods of heavy rain. Slopes range from 0 to 2 percent (see fig. 11).

Typical pedon of Oakalla silty clay loam, from the intersection of Ranch Road 1376 and Ranch Road 473 near Sisterdale, 2 miles west, 0.4 mile north on a private road, 0.4 mile east, and 50 feet north of the creek channel, in rangeland:

A11—0 to 15 inches; dark gray (10YR 4/1) silty clay loam, very dark gray (10YR 3/1) moist; weak moderate fine subangular blocky structure; hard, friable, sticky; common fine roots; 51 percent calcium carbonate equivalent; sand fraction consists of white limestone and crushed shells; calcareous; moderately alkaline; diffuse smooth boundary.

A12—15 to 26 inches; dark grayish brown (10YR 4/2) silty clay loam, very dark grayish brown (10YR 3/2) moist; moderate fine subangular blocky structure parting to moderate fine granular; hard, firm, sticky; common fine roots; 53 percent calcium carbonate equivalent; sand fraction consists of white angular limestone and crushed shells; calcareous; moderately alkaline; gradual smooth boundary.

B2—26 to 48 inches; brown (10YR 5/3) silty clay loam, dark brown (10YR 4/3) moist; moderate fine subangular blocky structure parting to moderate fine granular; hard, firm, sticky; common fine roots and pores; 42 percent calcium carbonate equivalent; few very fine weakly cemented bodies of calcium carbonate; calcareous; moderately akaline; gradual smooth boundary.

C—48 to 60 inches; grayish brown (10YR 5/2) silty clay loam, dark grayish brown (10YR 4/2) moist; massive; hard, firm, sticky; few films, threads, and weakly cemented bodies of calcium carbonate; few shell fragments; calcareous; moderately alkaline.

The calcium carbonate equivalent of the 10- to 40-inch control section ranges from 40 to 55 percent. The mollic epipedon is 20 to 34 inches thick. Limestone pebbles comprise as much as 10 percent of any horizon to a depth of 72 inches. The soil is silty clay loam, clay loam, or loam and contains 25 to 40 percent total clay. Carbonate clay ranges from 5 to 12 percent.

The A horizon is dark gray, very dark grayish brown, dark grayish brown, or dark brown. The B and C horizons are grayish brown, brown, yellowish brown, or light yellowish brown. In some pedons, gravel or contrasting textured sediments are at a depth of 6 to 10 feet.

Orif series

The Orif series consists of gently sloping, deep, well drained, gravelly, loamy soils on flood plains of high-gradient streams that drain areas of limestone. Periodic catastrophic floods deposit most of the coarse fragments, which are mainly limestone. Smaller floods deposit most of the sands, silts, and clays in which these soils formed. Slopes range from 1 to 5 percent (see fig. 12).

Typical pedon of Orif gravelly sandy loam, in an area of Orif-Boerne association, gently undulating, from the intersection of Ranch Road 1376 and Ranch Road 473 in Comfort, 1.3 miles west, and 2 miles south on a private ranch road to the Guadalupe River:

A11—0 to 6 inches; grayish brown (10YR 5/2) gravelly sandy loam, dark grayish brown (10YR 4/2) moist; weak medium subangular blocky structure; slightly hard, very friable; common fine grass roots; few fine tubes and pores; estimated 25 percent by volume rounded and waterworn limestone pebbles; calcareous; moderately alkaline; clear wavy boundary.

A12—6 to 16 inches; light brownish gray (10YR 6/2) gravelly sandy loam, grayish brown (10YR 5/2) moist; weak medium subangular blocky structure; slightly hard, very friable; few fine roots; many channels, pores, and insect burrows; estimated 20 percent by volume rounded and waterworn limestone pebbles; calcareous; moderately alkaline; diffuse wavy boundary.

IIC1—16 to 40 inches; light brownish gray (10YR 6/2) very gravelly loamy sand, grayish brown (10YR 5/2) moist; single grained; slightly hard, very friable; estimated 85 percent by volume rounded and waterworn limestone pebbles; calcareous; moderately alkaline; diffuse wavy boundary.

IIIC2—40 to 60 inches; light brownish gray (10YR 6/2) very gravelly fine sandy loam, grayish brown (10YR 5/2) moist; single grained; slightly hard, very friable; estimated 70 percent by volume rounded and waterworn limestone pebbles and estimated 20 percent by volume rounded and waterworn cobbles; calcareous, moderately alkaline.

Thickness of the solum ranges from 40 to 60 inches. The A horizon is brown, pale brown, light brownish gray, or grayish brown. The fine earth fraction is loam, fine sandy loam, or loamy fine sand. The C horizon is light brownish gray, light gray, very pale brown, or pale brown. The fine earth fraction averages loamy fine sand or fine sand, but a few strata range to sandy clay loam.

The A horizon contains from 20 to 30 percent by volume rounded and waterworn limestone fragments 1/4 to 3/4 inch in diameter. The IIC horizon contains from 70 to 90 percent by volume rounded and waterworn limestone pebbles from 1/2 inch to 6 inches in diameter, with a few fragments as much as 10 inches in diameter.

Real series

The Real series consists of hilly, shallow, well drained, gravelly and loamy soils that formed in interbedded

limestone and marl. These soils are on uplands. Slopes range from 8 to 20 percent (see fig. 3).

Typical pedon of Real gravelly clay loam, in an area of Brackett-Real association, hilly, approximately 3 miles west of Interstate Highway 10 on Cibolo Creek road to a subdivision entrance, 0.4 mile south on a paved road, and west 100 feet, in rangeland:

A11—0 to 5 inches; dark grayish brown (10YR 4/2) gravelly clay loam, very dark grayish brown (10YR 3/2) moist; weak fine subangular blocky structure parting to weak fine granular; hard, firm, sticky; many fine and common medium grass roots; estimated 20 percent by volume weakly cemented to strongly cemented angular limestone fragments 1/8 to 1 inch in diameter; calcareous; moderately alkaline; clear wavy boundary.

A12ca—5 to 14 inches; dark grayish brown (10YR 4/2) very gravelly clay loam, very dark grayish brown (10YR 3/2) moist; weak medium subangular blocky structure; hard, firm, sticky; many fine and common medium roots; estimated 40 percent by volume weakly cemented angular limestone fragments 1/2 inch to 3 inches in diameter with 1/16 to 1/4 inch discontinuous coatings of secondary calcium carbonate; few cobble- and stone-size fragments; calcareous; moderately alkaline; clear wavy boundary.

Cr—14 to 60 inches; light gray (2.5Y 7/2) weakly cemented limestone and marl of silt loam texture; massive; few medium tree roots in seams; calcareous; moderately alkaline.

Thickness of the solum ranges from 8 to 19 inches. Limestone fragments, 1/8 inch to 10 inches in diameter, make up 35 to 70 percent by volume of the solum. The estimated calcium carbonate equivalent in the fraction smaller than 2 millimeters is 55 to 70 percent. Texture is loam or clay loam and their gravelly or cobbly counterparts. The clay content ranges from 27 to 35 percent in the fine earth fraction.

The A horizon is dark grayish brown, dark brown, or very dark grayish brown. The Cr horizon is pale yellow, light yellowish brown, light gray, or white.

Tarpley series

The Tarpley series consists of gently undulating, shallow, well drained, clayey soils that formed in indurated limestone. These soils are on uplands. Slopes range from 1 to 5 percent.

Typical pedon of Tarpley clay in an area of Tarpley-Comfort association, gently undulating, from the intersection of Ranch Road 1376 and Ranch Road 473 at Sisterdale, 1.3 miles west, 1.5 miles south on a private ranch road, and 100 feet west, in rangeland:

A1—0 to 8 inches; dark reddish brown (5YR 3/2) clay, dark reddish brown (5YR 2.5/2) moist; moderate medium angular blocky structure; very hard, very firm, sticky and plastic; estimated 10 percent by volume angular chert fragments 1/4 inch to 3 inches in diameter; common fine and few medium roots; neutral; clear smooth boundary.

B2t—8 to 19 inches; reddish brown (2.5YR 4/4) clay, dark reddish brown (2.5YR 3/4) moist; strong coarse blocky structure; very hard, very firm, sticky and plastic; few fine roots; thin discontinuous clay films on peds; estimated 10 percent chert fragments 1/4 inch in diameter; neutral; abrupt smooth boundary.

R—19 to 20 inches; indurated limestone bedrock that is fractured and rough on the upper surfaces.

Thickness of the solum ranges from 13 to 20 inches. The A1 horizon is very dark grayish brown, dark reddish gray, dark reddish brown, reddish brown, or dark brown clay, or clay loam, or their stony counterparts. The Bt horizon is reddish brown, dark reddish brown, dark reddish gray, or dark brown clay or stony clay. Clay content ranges from 60 to 80 percent in the fine earth fraction.

Five to 20 percent of the soil is pebble-size fragments of limestone and chert. As much as 15 percent is cobbles. As much as 25 percent of the surface is covered with stones. Cracks that are as much as 3/4 inch wide at the surface extend to the limestone bedrock when the soil is dry and range from 1/8 to 1/4 inch in width. The mollic epipedon ranges from 7 inches thick in some pedons to the entire thickness of the soil in others. Reaction is neutral to mildly alkaline.

formation of the soils

In this section, five factors of soil formation are described and related to the soils in the survey area. The processes of soil formation are also described.

factors of soil formation

Soil is produced by the action of soil-forming processes on materials deposited or accumulated by geologic agencies. The characteristics of the soil are determined by the physical and mineralogical composition of the parent material; the climate under which the soil material has accumulated and existed since accumulation; the plant and animal life on and in the soil; the relief, or lay of the land; and the length of time the forces of soil development have acted on the soil material.

Climate and vegetation are active factors of soil genesis. They act on the parent material that has accumulated through the weathering of rocks and slowly change it into a natural body with genetically related horizons. The effects of climate and vegetation are modified by relief. The parent material also affects the kind of profile that can be formed and, in extreme cases, determines it almost entirely. Finally, time is needed for the changing of the parent material into a soil profile. It may be much or little, but some time is always required for horizon differentiation. Generally, a long time is required for the development of distinct horizons.

The factors of soil genesis are so closely interrelated in their effects on the soil that few generalizations can be made regarding the effect of any one factor unless conditions are specified for the other four.

parent material

Parent material is the unconsolidated mineral or organic matter from which the soil is formed. Parent material directly affects the texture, reaction, and rate of formation of the soil. Unconsolidated, or soft, materials weather faster and form soil more rapidly than consolidated, or hard, materials. Some examples of parent material are Glen Rose Limestone, Edwards Limestone, terrestrial sediment, and alluvial deposits (*3*). The fallout of atmospheric dust over long periods of time probably contributes significant amounts of material to soil on the more stable surfaces.

The type of parent material is probably the most important single factor in soil genesis and in determining the characteristics of the mature soil. Climate is probably the second most important factor. Topography, living organisms, and time interact with climate to form soil from the parent material.

climate

Climate is the total of all atmospheric influences. These influences are mainly temperature, wind, moisture, pressure, and evaporation. They combine to characterize a region, or land resource area, by influencing the nature of its land forms, soils, vegetation, and land use. Contrasted with climate, weather is the day to day conditions of climate. Kendall County has a dry, subhumid climate with periods of heavy, high intensity rainfall alternating with periods of major and minor drought.

The wet climate of past ages and the recession of the Cretaceous Sea influenced the deposition of parent materials in the valleys and the leaching of carbonates and illuviation of clays in mature soils. Precipitation, however, was limited in later years and did not leach the carbonates of the younger soils; therefore, they are calcareous to the surface. Carbonates have been leached from higher lying soils, and due to lateral seepage over the limestone, some of these carbonates have been deposited in soils on lower positions on the slopes.

living organisms

Vegetation, earthworms, insects, small rodents, and other animals contribute to soil formation. The mixed prairie grassland contributes large amounts of organic matter and organic acids which help to weather the parent material and reduce erosion. When the roots of grasses and trees decay, they leave a network of channels and pores that increase the passage of air and water through the soil. The roots provide a source of food for bacteria. Burrowing by earthworms, small rodents, insects, and other animals also facilitates the movement of air and water through the soil. These organisms disturb the soil and also affect the vegetation.

Man also contributes to the formation of soils. He has been both beneficial and detrimental to the soil by plowing, grazing, and burning vegetation off the land. Plowing and cultivating crops and overgrazing the rangeland have increased runoff and accelerated erosion. Burning the rangeland and crop residue has decreased the number of organisms in the soil, depleted

organic matter, and killed the vegetation. Man has reduced water intake of the soil by using poor tillage methods and has compacted the soil by using heavy machinery. He has been beneficial by controlling erosion, planting soil-improving crops, and irrigating the soil.

relief

Relief influences soil genesis by its effect on drainage, erosion, plant cover, and soil temperature. The undulating to steep soils, such as Brackett soils, absorb less moisture, are more erodible, and have less profile development than the nearly level, deeper soils, such as Barbarosa soils. The Barbarosa soils receive extra water, and carbonates are leached to depths below about 23 inches. Nuvalde soils are nearly level to gently sloping and have a dark surface horizon that is at least one-third of the thickness of the solum. Real soils are strongly sloping to steep and have north- and northwest-facing slopes. They receive less direct sunlight and lose less moisture than soils with south-facing slopes. The south-facing soils generally produce more vegetation and are darker.

time

The time during which climate, living organisms, and topography have acted upon parent material affects the kind of soil formed. Soils that do not have clearly defined horizons are considered young or immature, such as Entisols and Inceptisols, and are not in equilibrium with their environment. Soils that have undergone processes of weathering for long periods of time and have parent material that weathers easily have a horizon of clay accumulation (an argillic horizon) and are nearing equilibrium with their environment. Such soils are considered as rather mature soils, and in Kendall County they include the Alfisols and some of the Mollisols.

The formation of soil can take place in a very short time. Oakalla soils have a very simple genesis and formed from recently deposited alluvial sediment. It can take as long as 500,000 years, however, to form soils such as the Tarpley and Comfort soils, which have limestone parent material. This hard crystalline limestone parent material strongly resists weathering.

topography and geology

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topography

Kendall County lies on the southern edge of the Edwards Plateau of the Great Plains physiographic province. The uplifted Edwards Plateau has been strongly dissected by stream erosion, resulting in a rugged topography. The topography consists of four main geomorphic components: (1) the steep-sided, narrow canyons excavated from the Cretaceous carbonate rock formations; (2) the gently sloping interstream divides and uplands; (3) the broad valleys of the major streams; and (4) the stream courses. The altitude of the land surface ranges from about 1,100 feet at the southeastern edge of the county to about 2,100 feet in the north-central part.

The majority of the streams that have eroded headward into the plateau form narrow valleys with steep valley walls of carbonate strata. The major streams have developed wide valleys, some of which range from 3 to 5 miles in width, especially in the southeastern part of the county. The county has a well integrated drainage network which flows generally to the southeast. The northern and central parts of the county are drained by the Guadalupe River and its tributaries, the southern part is drained by Cibolo Creek and its tributaries, and the western part is drained by the tributaries of the Medina River. Tributaries of the Blanco River and the Pedernales River drain some areas in the northern part of the county.

geology

The principal geologic structure in Kendall County is a result of a warping of rock units into a broad, low syncline and an associated anticline. These structural features have a general northwestward trend across the county and plunge southward at a low angle towards the Balcones fault zone. Several small, discontinuous faults that have a northeastward trend are in this county. The faults have a small displacement and do not play a major role in the geologic structure of the county.

The principal geologic units, which are at the surface, are the Cow Creek Limestone Formation, the Glen Rose Formation, and the Edwards Limestone Formation. Each is from the Cretaceous age and has alluvial deposits of Pleistocene and Recent ages (see fig. 13).

The Cow Creek Limestone Formation is the oldest exposed geologic unit in the county and is the underlying material of Anhalt and Tarpley soils. It outcrops in the southeastern part of the county in an area where downcutting by the Guadalupe River has exposed the underlying formations. The Cow Creek Limestone Formation formed from massive, white limestone which was honeycombed at the outcrop by extensive solution activity. This rock unit is about 25 feet thick in the outcrop area.

The Glen Rose Formation outcrops extensively in the county. It is made up of alternating beds of limestone, dolomite, and marly limestone. About 60 percent of the section consists of marly limestone. It is the underlying material of Brackett, Denton, Doss, and Real soils. Differential erosion of these carbonate sequences produces a characteristic "stairstep topography" with the resistant limestone and dolomite supporting steep slopes and the less resistant marly limestone forming gentle slopes. Thickness of the formation ranges from about

730 feet in the southern part of the county to about 525 feet in the northern part.

The Edwards Limestone Formation is composed of limestone and dolomite with small amounts of marly limestone and chert. The Edwards Limestone outcrops in the northern and southern parts of the county, occurring either as a cap on isoloated hills or as an extensive upland surface. It is the underlying material of Comfort and Eckrant soils. This formation has a maximum thickness of 250 feet in the northern part of the county.

Alluvial deposits of gravel, sand, silt, and clay occur as flood plains, terraces, and alluvial fans. The flood plains are linear, narrow, and gently sloping areas adjacent to streams. They make up the underlying material of Boerne, Oakalla, and Orif soils. The terraces are adjacent to the flood plains, and in places they are at two or three levels. The terraces are not subject to normal flooding conditions. The Barbarosa and Nuvalde soils formed on these terraces. The alluvial fans are at the base of slopes and are recognized by their fan shape. Krum soils are on alluvial fans. Thickness of the alluvium is generally less than 50 feet, even in the broad Guadalupe River flood plain. The alluvial deposits are relatively young, ranging from Pleistocene to Recent age.

geologic history

The Cretaceous age began approximately 135 million years ago, when a transgression of the Cretaceous Sea spread across an ancient landmass composed of rocks of Paleozoic age. Cretaceous strata were deposited in warm, shallow seas, which were conducive to extensive carbonate accumulations. The older formations at the base of the sequence were overlapped by progressively younger formations. The sequence was generally thicker toward the sea, or to the southwest, and became thinner north of the advance of the seas. At the end of the Cretaceous age, approximately 60 to 70 million years ago, the seas retreated toward the Gulf of Mexico, and the area changed from a shallow, continental shelf and depositional area to an emergent land mass. Since the close of the Cretaceous age, water erosion has been the dominant agent shaping the surface of the area into hills, valleys, and plains.

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glossary

ABC soil. A soil having an A, a B, and a C horizon.

AC soil. A soil having only an A and a C horizon. Commonly such soil formed in recent alluvium or on steep rocky slopes.

Aeration, soil. The exchange of air in soil with air from the atmosphere. The air in a well aerated soil is similar to that in the atmosphere; the air in a poorly aerated soil is considerably higher in carbon dioxide and lower in oxygen.

Aggregate, soil. Many fine particles held in a single mass or cluster. Natural soil aggregates, such as granules, blocks, or prisms, are called peds. Clods are aggregates produced by tillage or logging.

Alluvium. Material, such as sand, silt, or clay, deposited on land by streams.

Area reclaim (in tables). An area difficult to reclaim after the removal of soil for construction and other uses. Revegetation and erosion control are extremely difficult.

Association, soil. A group of soils geographically associated in a characteristic repeating pattern and defined and delineated as a single map unit.

Available water capacity (available moisture capacity). The capacity of soils to hold water available for use by most plants. It is commonly defined as the difference between the amount of soil water at field moisture capacity and the amount at wilting point. It is commonly expressed as inches of water per inch of soil. The capacity, in inches, in a 60-inch profile or to a limiting layer is expressed as—

	Inches
Very low	0 to 3
Low	3 to 6
Moderate	6 to 9
High	9 to 12
Very high	More than 12

Bedrock. The solid rock that underlies the soil and other unconsolidated material or that is exposed at the surface.

Bottom land. The normal flood plain of a stream, subject to flooding.

Boulders. Rock fragments larger than 2 feet (60 centimeters) in diameter.

Calcareous soil. A soil containing enough calcium carbonate (commonly combined with magnesium carbonate) to effervesce visibly when treated with cold, dilute hydrochloric acid.

Caliche. A more or less cemented deposit of calcium carbonate in soils of warm-temperate, subhumid to arid areas. Caliche occurs as soft, thin layers in the soil or as hard, thick beds just beneath the solum, or it is exposed at the surface by erosion.

Clay. As a soil separate, the mineral soil particles less than 0.002 millimeter in diameter. As a soil textural class, soil material that is 40 percent or more clay, less than 45 percent sand, and less than 40 percent silt.

Clay film. A thin coating of oriented clay on the surface of a soil aggregate or lining pores or root channels. Synonyms: clay coating, clay skin.

Climax vegetation. The stabilized plant community on a particular site. The plant cover reproduces itself and does not change so long as the environment remains the same.

Coarse fragments. If round, mineral or rock particles 2 millimeters to 25 centimeters (10 inches) in diameter; if flat, mineral or rock particles (flagstone) 15.2 to 38.1 centimeters (6 to 15 inches) long.

Cobblestone (or cobble). A rounded or partly rounded fragment of rock 3 to 10 inches (7.5 to 25 centimeters) in diameter.

Compressible (in tables). Excessive decrease in volume of soft soil under load.

Consistence, soil. The feel of the soil and the ease with which a lump can be crushed by the fingers. Terms commonly used to describe consistence are—

Loose.—Noncoherent when dry or moist; does not hold together in a mass.

Friable.—When moist, crushes easily under gentle pressure between thumb and forefinger and can be pressed together into a lump.

Firm.—When moist, crushes under moderate pressure between thumb and forefinger, but resistance is distinctly noticeable.

Plastic.—When wet, readily deformed by moderate pressure but can be pressed into a lump; will form a "wire" when rolled between thumb and forefinger.

Sticky.—When wet, adheres to other material and tends to stretch somewhat and pull apart rather than to pull free from other material.

Hard.—When dry, moderately resistant to pressure; can be broken with difficulty between thumb and forefinger.

Soft.—When dry, breaks into powder or individual grains under very slight pressure.

Cemented.—Hard; little affected by moistening.

Corrosive. High risk of corrosion to uncoated steel or deterioration of concrete.

Cover crop. A close-growing crop grown primarily to improve and protect the soil between periods of regular crop production, or a crop grown between trees and vines in orchards and vineyards.

Cutbanks cave (in tables). The walls of excavations tend to cave in or slough.

Decreasers. The most heavily grazed climax range plants. Because they are the most palatable, they are the first to be destroyed by overgrazing.

Deferred grazing. Postponing grazing or arresting grazing for a prescribed period.

Depth to rock (in tables). Bedrock is too near the surface for the specified use.

Drainage class (natural). Refers to the frequency and duration of periods of saturation or partial saturation during soil formation, as opposed to altered drainage, which is commonly the result of artificial drainage or irrigation but may be caused by the sudden deepening of channels or the blocking of drainage outlets. Seven classes of natural soil drainage are recognized:

Excessively drained.—Water is removed from the soil very rapidly. Excessively drained soils are commonly very coarse textured, rocky, or shallow. Some are steep. All are free of the mottling related to wetness.

Somewhat excessively drained.—Water is removed from the soil rapidly. Many somewhat excessively drained soils are sandy and rapidly pervious. Some are shallow. Some are so steep that much of the water they receive is lost as runoff. All are free of the mottling related to wetness.

Well drained.—Water is removed from the soil readily, but not rapidly. It is available to plants throughout most of the growing season, and wetness does not inhibit growth of roots for significant periods during most growing seasons. Well drained soils are commonly medium textured. They are mainly free of mottling.

Moderately well drained.—Water is removed from the soil somewhat slowly during some periods. Moderately well drained soils are wet for only a short time during the growing season, but periodically they are wet long enough that most mesophytic crops are affected. They commonly have a slowly pervious layer within or directly below the solum, or periodically receive high rainfall, or both.

Somewhat poorly drained.—Water is removed slowly enough that the soil is wet for significant periods during the growing season. Wetness markedly restricts the growth of mesophytic crops unless artificial drainage is provided. Somewhat poorly drained soils commonly have a slowly pervious layer, a high water table, additional water from seepage, nearly continuous rainfall, or a combination of these.

Poorly drained.—Water is removed so slowly that the soil is saturated periodically during the growing season or remains wet for long periods. Free water is commonly at or near the surface for long enough during the growing season that most mesophytic crops cannot be grown unless the soil is artificially drained. The soil is not continuously saturated in layers directly below plow depth. Poor drainage results from a high water table, a slowly pervious layer within the profile, seepage, nearly continuous rainfall, or a combination of these.

Very poorly drained.—Water is removed from the soil so slowly that free water remains at or on the surface during most of the growing season. Unless the soil is artificially drained, most mesophytic crops cannot be grown. Very poorly drained soils are commonly level or depressed and are frequently ponded. Yet, where rainfall is high and nearly continuous, they can have moderate or high slope gradients.

Drainage, surface. Runoff, or surface flow of water, from an area.

Erosion. The wearing away of the land surface by water, wind, ice, or other geologic agents and by such processes as gravitational creep.

Erosion (geologic). Erosion caused by geologic processes acting over long geologic periods and resulting in the wearing away of mountains and the building up of such landscape features as flood plains and coastal plains. Synonym: natural erosion.

Erosion (accelerated). Erosion much more rapid than geologic erosion, mainly as a result of the activities of man or other animals or of a catastrophe in nature, for example, fire, that exposes the surface.

Excess fines (in tables). Excess silt and clay in the soil. The soil does not provide a source of gravel or sand for construction purposes.

Excess lime (in tables). Excess carbonates in the soil that restrict the growth of some plants.

Fast intake (in tables). The rapid movement of water into the soil.

Fertility, soil. The quality that enables a soil to provide plant nutrients, in adequate amounts and in proper balance, for the growth of specified plants when light, moisture, temperature, tilth, and other growth factors are favorable.

Fine textured soil. Sandy clay, silty clay, and clay.

Flood plain. A nearly level alluvial plain that borders a stream and is subject to flooding unless protected artificially.

Foot slope. The inclined surface at the base of a hill.

Forb. Any herbaceous plant not a grass or a sedge.

Genesis, soil. The mode of origin of the soil. Refers especially to the processes or soil-forming factors responsible for the formation of the solum, or true soil, from the unconsolidated parent material.

Gilgai. Commonly a succession of microbasins and microknolls in nearly level areas or of microvalleys and microridges parallel with the slope. Typically, the microrelief of Vertisols—clayey soils having a high coefficient of expansion and contraction with changes in moisture content.

Grassed waterway. A natural or constructed waterway, typically broad and shallow, seeded to grass as protection against erosion. Conducts surface water away from cropland.

Gravel. Rounded or angular fragments of rock up to 3 inches (2 millimeters to 7.5 centimeters) in diameter. An individual piece is a pebble.

Gravelly soil material. Material that is 15 to 50 percent, by volume, rounded or angular rock fragments, not prominently flattened, up to 3 inches (7.5 centimeters) in diameter.

Green manure crop (agronomy). A soil-improving crop grown to be plowed under in an early stage of maturity or soon after maturity.

Gully. A miniature valley with steep sides cut by running water and through which water ordinarily runs only after rainfall. The distinction between a gully and a rill is one of depth. A gully generally is an obstacle to farm machinery and is too deep to be obliterated by ordinary tillage; a rill is of lesser depth and can be smoothed over by ordinary tillage.

Horizon, soil. A layer of soil, approximately parallel to the surface, having distinct characteristics produced by soil-forming processes. In the identification of soil horizons, an upper case letter represents the major horizons. Numbers or lower case letters that follow represent subdivisions of the major horizons. An explanation of the subdivisions is given in the *Soil Survey Manual*. The major horizons of mineral soil are as follows:

O horizon.—An organic layer of fresh and decaying plant residue at the surface of a mineral soil.

A horizon.—The mineral horizon at or near the surface in which an accumulation of humified organic matter is mixed with the mineral material. Also, a plowed surface horizon, most of which was originally part of a B horizon.

B horizon.—The mineral horizon below an A horizon. The B horizon is in part a layer of transition from the overlying A to the underlying C horizon. The B horizon also has distinctive characteristics such as (1) accumulation of clay, sesquioxides, humus, or a combination of these; (2) prismatic or blocky structure; (3) redder or browner colors than those in the A horizon; or (4) a combination of these. The combined A and B horizons are generally called the solum, or true soil. If a soil does not have a B horizon, the A horizon alone is the solum.

C horizon.—The mineral horizon or layer, excluding indurated bedrock, that is little affected by soil-forming processes and does not have the properties typical of the A or B horizon. The material of a C horizon may be either like or unlike that in which the solum formed. If the material is known to differ from that in the solum, the Roman numeral II precedes the letter C.

R layer.—Consolidated rock beneath the soil. The rock commonly underlies a C horizon, but can be directly below an A or a B horizon.

Humus. The well decomposed, more or less stable part of the organic matter in mineral soils.

Hydrologic soil groups. Refers to soils grouped according to their runoff-producing characteristics. The chief consideration is the inherent capacity of soil bare of vegetation to permit infiltration. The slope and the kind of plant cover are not considered but are separate factors in predicting runoff. Soils are assigned to four groups. In group A are soils having a high infiltration rate when thoroughly wet and having a low runoff potential. They are mainly deep, well drained, and sandy or gravelly. In group D, at the other extreme, are soils having a very slow infiltration rate and thus a high runoff potential. They have a claypan or clay layer at or near the surface, have a permanent high water table, or are shallow over nearly impervious bedrock or other material. A soil is assigned to two hydrologic groups if part of the acreage is artificially drained and part is undrained.

Impervious soil. A soil through which water, air, or roots penetrate slowly or not at all. No soil is absolutely impervious to air and water all the time.

Increasers. Species in the climax vegetation that increase in amount as the more desirable plants are reduced by close grazing. Increasers commonly are the shorter plants and the less palatable to livestock.

Infiltration. The downward entry of water into the immediate surface of soil or other material, as contrasted with percolation, which is movement of water through soil layers or material.

Infiltration rate. The rate at which water penetrates the surface of the soil at any given instant, usually expressed in inches per hour. The rate can be limited by the infiltration capacity of the soil or the rate at which water is applied at the surface.

Intake rate. The average rate of water entering the soil under irrigation. Most soils have a fast initial rate; the rate decreases with application time. Therefore, intake rate for design purposes is not a constant but is a variable depending on the net irrigation application. The rate of water intake in inches per hour is expressed as follows:

Less than 0.2	very low
0.2 to 0.4	low
0.4 to 0.75	moderately low
0.75 to 1.25	moderate
1.25 to 1.75	moderately high
1.75 to 2.5	high
More than 2.5	very high

Invaders. On range, plants that encroach into an area and grow after the climax vegetation has been

reduced by grazing. Generally, invader plants follow disturbance of the surface.

Irrigation. Application of water to soils to assist in production of crops. Methods of irrigation are—
Border.—Water is applied at the upper end of a strip in which the lateral flow of water is controlled by small earth ridges called border dikes, or borders.
Basin.—Water is applied rapidly to nearly level plains surrounded by levees or dikes.
Controlled flooding.—Water is released at intervals from closely spaced field ditches and distributed uniformly over the field.
Corrugation.—Water is applied to small, closely spaced furrows or ditches in fields of close-growing crops or in orchards so that it flows in only one direction.
Drip (or trickle).—Water is applied slowly and under low pressure to the surface of the soil or into the soil through such applicators as emitters, porous tubing, or perforated pipe.
Furrow.—Water is applied in small ditches made by cultivation implements. Furrows are used for tree and row crops.
Sprinkler.—Water is sprayed over the soil surface through pipes or nozzles from a pressure system.
Subirrigation.—Water is applied in open ditches or tile lines until the water table is raised enough to wet the soil.
Wild flooding.—Water, released at high points, is allowed to flow onto an area without controlled distribution.

Large stones (in tables). Rock fragments 3 inches (7.5 centimeters) or more across. Large stones adversely affect the specified use of the soil.

Leaching. The removal of soluble material from soil or other material by percolating water.

Liquid limit. The moisture content at which the soil passes from a plastic to a liquid state.

Loam. Soil material that is 7 to 27 percent clay particles, 28 to 50 percent silt particles, and less than 52 percent sand particles.

Low strength. The soil is not strong enough to support loads.

Medium textured soil. Very fine sandy loam, loam, silt loam, or silt.

Mineral soil. Soil that is mainly mineral material and low in organic material. Its bulk density is more than that of organic soil.

Minimum tillage. Only the tillage essential to crop production and prevention of soil damage.

Moderately coarse textured soil. Sandy loam and fine sandy loam.

Moderately fine textured soil. Clay loam, sandy clay loam, and silty clay loam.

Morphology, soil. The physical makeup of the soil, including the texture, structure, porosity, consistence, color, and other physical, mineral, and biological properties of the various horizons, and the thickness and arrangement of those horizons in the soil profile.

Munsell notation. A designation of color by degrees of the three simple variables—hue, value, and chroma. For example, a notation of 10YR 6/4 is a color of 10YR hue, value of 6, and chroma of 4.

Neutral soil. A soil having a pH value between 6.6 and 7.3. (See Reaction, soil.)

Nutrient, plant. Any element taken in by a plant essential to its growth. Plant nutrients are mainly nitrogen, phosphorus, potassium, calcium, magnesium, sulfur, iron, manganese, copper, boron, and zinc obtained from the soil and carbon, hydrogen, and oxygen obtained from the air and water.

Organic matter. Plant and animal residue in the soil in various stages of decomposition.

Parent material. The unconsolidated organic and mineral material in which soil forms.

Ped. An individual natural soil aggregate, such as a granule, a prism, or a block.

Percolation. The downward movement of water through the soil.

Percs slowly (in tables). The slow movement of water through the soil adversely affecting the specified use.

Permeability. The quality of the soil that enables water to move downward through the profile. Permeability is measured as the number of inches per hour that water moves downward through the saturated soil. Terms describing permeability are:

Very slow	less than 0.06 inch
Slow	0.06 to 0.20 inch
Moderately slow	0.2 to 0.6 inch
Moderate	0.6 inch to 2.0 inches
Moderately rapid	2.0 to 6.0 inches
Rapid	6.0 to 20 inches
Very rapid	more than 20 inches

Phase, soil. A subdivision of a soil series based on features that affect its use and management. For example, slope, stoniness, and thickness.

pH value. A numerical designation of acidity and alkalinity in soil. (See Reaction, soil.)

Plasticity index. The numerical difference between the liquid limit and the plastic limit; the range of moisture content within which the soil remains plastic.

Plastic limit. The moisture content at which a soil changes from semisolid to plastic.

Ponding. Standing water on soils in closed depressions. The water can be removed only by percolation or evapotranspiration.

Poorly graded. Refers to a coarse grained soil or soil material consisting mainly of particles of nearly the same size. Because there is little difference in size of the particles, density can be increased only slightly by compaction.

Poor outlets (in tables). Refers to areas where surface or subsurface drainage outlets are difficult or expensive to install.

Productivity, soil. The capability of a soil for producing a specified plant or sequence of plants under specific management.

Profile, soil. A vertical section of the soil extending through all its horizons and into the parent material.

Rangeland. Land on which the potential natural vegetation is predominantly grasses, grasslike plants, forbs, or shrubs suitable for grazing or browsing. It includes natural grasslands, savannas, many wetlands, some deserts, tundras, and areas that support certain forb and shrub communities.

Range condition. The present composition of the plant community on a range site in relation to the potential natural plant community for that site. Range condition is expressed as excellent, good, fair, or poor, on the basis of how much the present plant community has departed from the potential.

Range site. An area of rangeland where climate, soil, and relief are sufficiently uniform to produce a distinct natural plant community. A range site is the product of all the environmental factors responsible for its development. It is typified by an association of species that differ from those on other range sites in kind or proportion of species or total production.

Reaction, soil. A measure of acidity or alkalinity of a soil, expressed in pH values. A soil that tests to pH 7.0 is described as precisely neutral in reaction because it is neither acid nor alkaline. The degree of acidity or alkalinity is expressed as—

	pH
Extremely acid	Below 4.5
Very strongly acid	4.5 to 5.0
Strongly acid	5.1 to 5.5
Medium acid	5.6 to 6.0
Slightly acid	6.1 to 6.5
Neutral	6.6 to 7.3
Mildly alkaline	7.4 to 7.8
Moderately alkaline	7.9 to 8.4
Strongly alkaline	8.5 to 9.0
Very strongly alkaline	9.1 and higher

Regolith. The unconsolidated mantle of weathered rock and soil material on the earth's surface; the loose earth material above the solid rock.

Relief. The elevations or inequalities of a land surface, considered collectively.

Rill. A steep sided channel resulting from accelerated erosion. A rill is generally a few inches deep and not wide enough to be an obstacle to farm machinery.

Rippable. Bedrock or hardpan can be excavated using a single-tooth ripping attachment mounted on a tractor with a 200-300 draw bar horsepower rating.

Rock fragments. Rock or mineral fragments having a diameter of 2 millimeters or more; for example, pebbles, cobbles, stones, and boulders.

Rooting depth (in tables). Shallow root zone. The soil is shallow over a layer that greatly restricts roots.

Root zone. The part of the soil that can be penetrated by plant roots.

Runoff. The precipitation discharged into stream channels from an area. The water that flows off the surface of the land without sinking into the soil is called surface runoff. Water that enters the soil before reaching surface streams is called ground-water runoff or seepage flow from ground water.

Sand. As a soil separate, individual rock or mineral fragments from 0.05 millimeter to 2.0 millimeters in diameter. Most sand grains consist of quartz. As a soil textural class, a soil that is 85 percent or more sand and not more than 10 percent clay.

Sandstone. Sedimentary rock containing dominantly sand-size particles.

Sedimentary rock. Rock made up of particles deposited from suspension in water. The chief kinds of sedimentary rock are conglomerate, formed from gravel; sandstone, formed from sand; shale, formed from clay; and limestone, formed from soft masses of calcium carbonate. There are many intermediate types. Some wind-deposited sand is consolidated into sandstone.

Seepage (in tables). The movement of water through the soil. Seepage adversely affects the specified use.

Series, soil. A group of soils that have profiles that are almost alike, except for differences in texture of the surface layer or of the underlying material. All the soils of a series have horizons that are similar in composition, thickness, and arrangement.

Sheet erosion. The removal of a fairly uniform layer of soil material from the land surface by the action of rainfall and runoff water.

Shrink-swell (Shrinking and swelling). The shrinking of soil when dry and the swelling when wet. Shrinking and swelling can damage roads, dams, building foundations, and other structures. It can also damage plant roots.

Silt. As a soil separate, individual mineral particles that range in diameter from the upper limit of clay (0.002 millimeter) to the lower limit of very fine sand (0.05 millimeter). As a soil textural class, soil that is 80 percent or more silt and less than 12 percent clay.

Slickensides. Polished and grooved surfaces produced by one mass sliding past another. In soils, slickensides may occur at the bases of slip surfaces on the steeper slopes; on faces of blocks, prisms, and columns; and in swelling clayey soils, where there is marked change in moisture content.

Slope. The inclination of the land surface from the horizontal. Percentage of slope is the vertical distance divided by horizontal distance, then multiplied by 100. Thus, a slope of 20 percent is a drop of 20 feet in 100 feet of horizontal distance.

Slow intake (in tables). The slow movement of water into the soil.

Soil. A natural, three-dimensional body at the earth's surface. It is capable of supporting plants and has properties resulting from the integrated effect of climate and living matter acting on earthy parent material, as conditioned by relief over periods of time.

Soil separates. Mineral particles less than 2 mm in equivalent diameter and ranging between specified size limits. The names and sizes of separates recognized in the United States are as follows:

	Millimeters
Very coarse sand	2.0 to 1.0
Coarse sand	1.0 to 0.5
Medium sand	0.5 to 0.25
Fine sand	0.25 to 0.10
Very fine sand	0.10 to 0.05
Silt	0.05 to 0.002
Clay	less than 0.002

Solum. The upper part of a soil profile, above the C horizon, in which the processes of soil formation are active. The solum in soil consists of the A and B horizons. Generally, the characteristics of the material in these horizons are unlike those of the underlying material. The living roots and plant and animal activities are largely confined to the solum.

Stones. Rock fragments 10 to 24 inches (25 to 60 centimeters) in diameter.

Stony. Refers to a soil containing stones in numbers that interfere with or prevent tillage.

Structure, soil. The arrangement of primary soil particles into compound particles or aggregates. The principal forms of soil structure are—*platy* (laminated), *prismatic* (vertical axis of aggregates longer than horizontal), *columnar* (prisms with rounded tops), *blocky* (angular or subangular), and *granular. Structureless* soils are either *single grained* (each grain by itself, as in dune sand) or *massive* (the particles adhering without any regular cleavage, as in many hardpans).

Subsoil. Technically, the B horizon; roughly, the part of the solum below plow depth.

Surface layer. The soil ordinarily moved in tillage, or its equivalent in uncultivated soil, ranging in depth from 4 to 10 inches (10 to 25 centimeters). Frequently designated as the "plow layer," or the "Ap horizon."

Terrace. An embankment, or ridge, constructed across sloping soils on the contour or at a slight angle to the contour. The terrace intercepts surface runoff so that water soaks into the soil or flows slowly to a prepared outlet. A terrace in a field is generally built so that the field can be farmed. A terrace intended mainly for drainage has a deep channel that is maintained in permanent sod.

Texture, soil. The relative proportions of sand, silt, and clay particles in a mass of soil. The basic textural classes, in order of increasing proportion of fine particles, are *sand, loamy sand, sandy loam, loam, silt loam, silt, sandy clay loam, clay loam, silty clay loam, sandy clay, silty clay,* and *clay*. The sand, loamy sand, and sandy loam classes may be further divided by specifying "coarse," "fine," or "very fine."

Thin layer (in tables). Otherwise suitable soil material too thin for the specified use.

Tilth, soil. The physical condition of the soil as related to tillage, seedbed preparation, seedling emergence, and root penetration.

Topsoil. The upper part of the soil, which is the most favorable material for plant growth. It is ordinarily rich in organic matter and is used to topdress roadbanks, lawns, and land affected by mining.

Unstable fill (in tables). Risk of caving or sloughing on banks of fill material.

Upland (geology). Land at a higher elevation, in general, than the alluvial plain or stream terrace; land above the lowlands along streams.

Valley fill. In glaciated regions, material deposited in stream valleys by glacial melt water. In nonglaciated regions, alluvium deposited by heavily loaded streams.

Weathering. All physical and chemical changes produced in rocks or other deposits at or near the earth's surface by atmospheric agents. These changes result in disintegration and decomposition of the material.

Well graded. Refers to soil material consisting of coarse grained particles that are well distributed over a wide range in size or diameter. Such soil normally can be easily increased in density and bearing properties by compaction. Contrasts with poorly graded soil.

Wilting point (or permanent wilting point). The moisture content of soil, on an ovendry basis, at which a plant (specifically sunflower) wilts so much that it does not recover when placed in a humid, dark chamber.

tables

TABLE 1.--TEMPERATURE AND PRECIPITATION

[Recorded in the period 1951-74 at Kerrville, Texas]

Month	Temperature						Precipitation				
	Average daily maximum	Average daily minimum	Average daily	2 years in 10 will have-- Maximum temperature higher than--	2 years in 10 will have-- Minimum temperature lower than--	Average number of growing degree days[1]	Average	2 years in 10 will have-- Less than--	2 years in 10 will have-- More than--	Average number of days with 0.10 inch or more	Average snowfall
	°F	°F	°F	°F	°F	Units	In	In	In		In
January----	60.2	30.9	45.6	83	10	69	1.41	.21	2.33	3	.0
February---	63.3	34.4	48.8	86	12	91	1.95	.69	2.95	4	.6
March------	70.9	41.5	56.2	93	20	238	1.75	.47	2.76	4	.2
April------	78.8	51.6	65.3	95	29	459	2.74	.92	4.18	5	.0
May--------	83.5	59.0	71.3	97	37	660	3.88	1.46	5.83	6	.0
June-------	90.0	66.0	78.0	100	51	840	2.42	.49	3.91	4	.0
July-------	93.6	67.8	80.7	102	59	952	1.81	.27	2.96	3	.0
August-----	93.9	66.6	80.3	103	56	939	2.77	.38	4.55	4	.0
September--	88.4	61.9	75.2	102	43	756	3.79	1.16	5.89	6	.0
October----	79.3	51.2	65.3	94	30	474	3.97	1.01	6.36	5	.0
November---	68.3	40.3	54.3	86	20	176	1.60	.58	2.44	4	.2
December---	62.5	32.8	47.7	82	13	75	1.48	.36	2.36	3	.0
Yearly:											
Average--	77.7	50.3	64.1	---	---	---	---	---	---	---	---
Extreme--	---	---	---	104	7	---	---	---	---	---	---
Total----	---	---	---	---	---	5,729	29.57	21.06	37.90	51	1.0

[1]A growing degree day is a unit of heat available for plant growth. It can be calculated by adding the maximum and minimum daily temperatures, dividing the sum by 2, and subtracting the temperature below which growth is minimal for the principal crops in the area (50° F).

TABLE 2.--FREEZE DATES IN SPRING AND FALL

[Recorded in the period 1951-74 at Kerrville, Texas]

Probability	Temperature		
	24° F or lower	28° F or lower	32° F or lower
Last freezing temperature in spring:			
1 year in 10 later than--	March 26	April 8	April 15
2 years in 10 later than--	March 19	March 31	April 10
5 years in 10 later than--	March 5	March 18	March 31
First freezing temperature in fall:			
1 year in 10 earlier than--	November 8	October 27	October 18
2 years in 10 earlier than--	November 14	November 1	October 23
5 years in 10 earlier than--	November 26	November 12	November 1

TABLE 3.--GROWING SEASON

[Recorded in the period 1951-74 at Kerrville, Texas]

Probability	Daily minimum temperature during growing season		
	Higher than 24° F	Higher than 28° F	Higher than 32° F
	Days	Days	Days
9 years in 10	237	217	194
8 years in 10	247	224	201
5 years in 10	266	239	214
2 years in 10	285	253	227
1 year in 10	295	260	234

TABLE 4.-- SUITABILITIES AND LIMITATIONS OF MAP UNITS ON THE GENERAL SOIL MAP

Map unit	Extent of area	Cultivated crops	Rangeland	Urban uses	Recreation areas	Sanitary facilities
	Pct					
1. Brackett-Eckrant	20	Poorly suited: shallow rooting depth, stones, low available water capacity.	Moderately well suited: shallow rooting depth, low available water capacity, rapid runoff.	Poorly suited: depth to rock, slope.	Poorly suited: depth to rock, slope, percs slowly, too clayey.	Poorly suited: depth to rock, slope, percs slowly.
2. Doss-Brackett	50	Poorly suited: shallow rooting depth, small stones.	Moderately well suited: shallow rooting depth, low available water capacity.	Poorly suited: depth to rock.	Poorly suited: depth to rock.	Poorly suited: depth to rock.
3. Eckrant-Comfort-Tarpley	20	Poorly suited: shallow rooting depth, stones, low available water capacity.	Moderately well suited: shallow rooting depth, low available water capacity, rapid runoff.	Poorly suited: depth to rock, stoniness, corrosivity.	Poorly suited: depth to rock, too clayey, stones, percs slowly.	Poorly suited: depth to rock, percs slowly.
4. Oakalla-Boerne-Nuvalde	10	Well suited----	Moderately well suited: droughtiness.	Poorly suited: flooding.	Moderately well suited: percs slowly, too clayey, flooding.	Poorly suited: flooding.

TABLE 5.--ACREAGE AND PROPORTIONATE EXTENT OF THE SOILS

Map symbol	Soil name	Acres	Percent
1	Anhalt clay, 1 to 3 percent slopes	5,091	1.2
2	Barbarosa silty clay loam, 0 to 1 percent slopes	1,280	0.3
3	Boerne fine sandy loam	6,691	1.6
4	Brackett association, undulating	25,160	5.9
5	Brackett-Real association, hilly	90,241	21.0
6	Denton silty clay, 1 to 3 percent slopes	11,448	2.7
7	Denton silty clay, 3 to 5 percent slopes	1,924	0.4
8	Doss silty clay, 1 to 5 percent slopes	18,947	4.4
9	Doss-Brackett association, undulating	73,269	17.1
10	Eckrant-Comfort association, gently undulating	84,155	19.6
11	Eckrant-Rock outcrop association, steep	33,443	7.8
12	Krum silty clay, 1 to 3 percent slopes	11,600	2.7
13	Krum silty clay, 3 to 5 percent slopes	20,707	4.8
14	Nuvalde silty clay, 0 to 1 percent slopes	1,306	0.3
15	Nuvalde silty clay, 1 to 3 percent slopes	5,994	1.4
16	Oakalla silty clay loam	10,046	2.3
17	Orif-Boerne association, gently undulating	2,852	0.7
18	Tarpley clay, 1 to 3 percent slopes	1,997	0.5
19	Tarpley-Comfort association, gently undulating	22,649	5.3
	Total	428,800	100.0

TABLE 6.--YIELDS PER ACRE OF CROPS AND PASTURE

[Yields are those that can be expected under a high level of management. Absence of a yield indicates that the soil is not suited to the crop or the crop generally is not grown on the soil. Only soils suitable for these crops are listed]

Map symbol and soil name	Oats	Grain sorghum	Improved bermudagrass pasture
	Lb	Bu	AUM*
1--- Anhalt	50	45	5.0
2--- Barbarosa	70	90	8.0
3--- Boerne	---	35	4.0
6--- Denton	60	65	6.0
7--- Denton	50	55	6.0
8--- Doss	---	---	4.0
9:**			
Doss---	---	---	4.0
Brackett---	---	---	---
12--- Krum	70	70	8.0
13--- Krum	50	65	6.0
14--- Nuvalde	55	40	5.0
15--- Nuvalde	50	35	5.0
16--- Oakalla	60	65	6.5
17:**			
Orif---	---	---	4.0
Boerne---	---	35	4.0
18--- Tarpley	30	25	2.5

* Animal-unit-month: The amount of forage or feed required to feed one animal unit (one cow, one horse, one mule, five sheep, or five goats) for 30 days.

** See description of the map unit for composition and behavior characteristics of the map unit.

TABLE 7.--CAPABILITY CLASSES AND SUBCLASSES

[Miscellaneous areas are excluded. Absence of an entry indicates no acreage]

Class	Total acreage	Major management concerns (Subclass)			
		Erosion (e)	Wetness (w)	Soil problem (s)	Climate (c)
		Acres	Acres	Acres	Acres
I	---	---	---	---	---
II	48,365	35,733	10,046	1,280	1,306
III	48,666	48,666	---	---	---
IV	---	---	---	---	---
V	---	---	---	---	---
VI	107,775	35,169	---	72,606	---
VII	202,637	---	---	202,637	---
VIII	---	---	---	---	---

TABLE 8.--RECREATIONAL DEVELOPMENT

[Some terms that describe restrictive soil features are defined in the Glossary. See text for definitions of "slight," "moderate," and "severe"]

Map symbol and soil name	Camp areas	Picnic areas	Playgrounds	Paths and trails	Golf fairways
1--Anhalt	Moderate: percs slowly, too clayey.	Moderate: too clayey, percs slowly.	Severe: too clayey, percs slowly.	Moderate: too clayey.	Severe: too clayey.
2--Barbarosa	Slight	Slight	Moderate: percs slowly.	Slight	Slight.
3--Boerne	Severe: floods.	Slight	Moderate: floods.	Slight	Moderate: excess lime.
4*--Brackett	Severe: depth to rock.	Severe: depth to rock.	Severe: small stones, depth to rock.	Slight	Severe: thin layer.
5:*					
Brackett	Severe: slope, depth to rock.	Severe: slope, depth to rock.	Severe: slope, small stones, depth to rock.	Moderate: slope.	Severe: slope, thin layer.
Real	Severe: slope, small stones, depth to rock.	Severe: slope, small stones, depth to rock.	Severe: slope, small stones, depth to rock.	Severe: small stones.	Severe: small stones, slope, thin layer.
6, 7--Denton	Moderate: too clayey.	Moderate: too clayey.	Moderate: slope, small stones, too clayey.	Moderate: too clayey.	Severe: too clayey.
8--Doss	Severe: depth to rock.	Severe: depth to rock.	Severe: depth to rock.	Moderate: too clayey.	Severe: thin layer.
9:*					
Doss	Severe: depth to rock.	Severe: depth to rock.	Severe: depth to rock.	Moderate: too clayey.	Severe: thin layer.
Brackett	Severe: depth to rock.	Severe: depth to rock.	Severe: small stones, depth to rock.	Slight	Severe: thin layer.
10:*					
Eckrant	Severe: large stones, depth to rock.	Severe: large stones, depth to rock.	Severe: large stones, depth to rock.	Severe: large stones.	Severe: large stones, thin layer.
Comfort	Severe: depth to rock.	Severe: depth to rock.	Severe: too clayey, depth to rock.	Moderate: large stones, too clayey.	Severe: large stones, thin layer, too clayey.
11:*					
Eckrant	Severe: large stones, depth to rock.	Severe: large stones, depth to rock.	Severe: large stones, slope, depth to rock.	Severe: large stones.	Severe: large stones, thin layer.
Rock outcrop.					
12, 13--Krum	Moderate: too clayey.	Moderate: too clayey.	Moderate: small stones, slope.	Moderate: too clayey.	Severe: too clayey.

See footnote at end of table.

TABLE 8.--RECREATIONAL DEVELOPMENT--Continued

Map symbol and soil name	Camp areas	Picnic areas	Playgrounds	Paths and trails	Golf fairways
14---------- Nuvalde	Moderate: too clayey.	Moderate: too clayey.	Moderate: too clayey.	Moderate: too clayey.	Severe: too clayey.
15---------- Nuvalde	Moderate: too clayey.	Moderate: too clayey.	Moderate: too clayey, slope.	Moderate: too clayey.	Severe: too clayey.
16---------- Oakalla	Severe: floods.	Slight----------	Moderate: floods.	Slight----------	Moderate: excess lime.
17:*					
Orif----------	Severe: floods, small stones.	Severe: small stones.	Severe: small stones, floods.	Moderate: floods.	Severe: small stones, droughty, floods.
Boerne----------	Severe: floods.	Moderate: floods.	Severe: floods.	Moderate: floods.	Severe: floods, excess lime.
18---------- Tarpley	Severe: depth to rock.	Severe: depth to rock.	Severe: depth to rock.	Slight----------	Severe: thin layer.
19:*					
Tarpley----------	Severe: depth to rock.	Severe: depth to rock.	Severe: depth to rock.	Slight----------	Severe: thin layer.
Comfort----------	Severe: depth to rock.	Severe: depth to rock.	Severe: too clayey, depth to rock.	Moderate: large stones, too clayey.	Severe: large stones, thin layer, too clayey.

* See description of the map unit for composition and behavior characteristics of the map unit.

TABLE 9.--WILDLIFE HABITAT

[See text for definitions of "good," "fair," "poor," and "very poor"]

Map symbol and soil name	Potential for habitat elements						Potential as habitat for--		
	Grain and seed crops	Grasses and legumes	Wild herbaceous plants	Shrubs	Wetland plants	Shallow water areas	Openland wildlife	Wetland wildlife	Rangeland wildlife
1---------- Anhalt	Good	Good	Fair	Fair	Poor	Very poor	Good	Very poor	Fair.
2---------- Barbarosa	Good	Good	Fair	Fair	Poor	Very poor	Good	Very poor	Fair.
3---------- Boerne	Fair	Fair	Good	Fair	Poor	Very poor	Fair	Very poor	Fair.
4*---------- Brackett	Fair	Good	Fair	Fair	Poor	Very poor	Fair	Very poor	Fair.
5:*									
Brackett----------	Very poor	Very poor	Fair	Fair	Very poor	Very poor	Very poor	Very poor	Fair.
Real----------	Very poor	Very poor	Poor	Fair	Very poor	Very poor	Very poor	Very poor	Poor.
6---------- Denton	Good	Good	Fair	Fair	Poor	Very poor	Good	Very poor	Fair.
7---------- Denton	Fair	Good	Fair	Fair	Poor	Very poor	Fair	Very poor	Fair.
8---------- Doss	Fair	Good	Fair	Fair	Poor	Very poor	Fair	Very poor	Fair.
9:*									
Doss----------	Fair	Good	Fair	Fair	Poor	Very poor	Fair	Very poor	Fair.
Brackett----------	Fair	Good	Fair	Fair	Poor	Very poor	Fair	Very poor	Fair.
10:*									
Eckrant----------	Very poor	Very poor	Fair	Fair	Very poor	Very poor	Poor	Very poor	Fair.
Comfort----------	Poor	Poor	Fair	Good	Poor	Very poor	Poor	Very poor	Fair.
11:*									
Eckrant----------	Very poor	Very poor	Fair	Fair	Very poor	Very poor	Poor	Very poor	Fair.
Rock outcrop.									
12---------- Krum	Good	Good	Fair	Fair	Poor	Very poor	Good	Very poor	Fair.
13---------- Krum	Fair	Good	Fair	Fair	Poor	Very poor	Fair	Very poor	Fair.
14, 15---------- Nuvalde	Good	Good	Fair	Fair	Poor	Very poor	Good	Very poor	Fair.
16---------- Oakalla	Good	Good	Good	Good	Poor	Very poor	Good	Very poor	Good.
17:*									
Orif----------	Poor	Poor	Fair	Good	Poor	Very poor	Fair	Very poor	Fair.
Boerne----------	Fair	Fair	Good	Fair	Poor	Very poor	Fair	Very poor	Fair.
18---------- Tarpley	Fair	Fair	Fair	Fair	Poor	Very poor	Fair	Very poor	Fair.
19:*									
Tarpley----------	Poor	Poor	Fair	Good	Poor	Very poor	Poor	Very poor	Fair.
Comfort----------	Poor	Poor	Fair	Good	Poor	Very poor	Poor	Very poor	Fair.

* See description of the map unit for composition and behavior characteristics of the map unit.

TABLE 10.--BUILDING SITE DEVELOPMENT

[Some terms that describe restrictive soil features are defined in the Glossary. See text for definitions of "slight," "moderate," and "severe"]

Map symbol and soil name	Shallow excavations	Dwellings without basements	Dwellings with basements	Small commercial buildings	Local roads and streets	Lawns and landscaping
1---------- Anhalt	Severe: depth to rock, cutbanks cave.	Severe: shrink-swell.	Severe: depth to rock, shrink-swell.	Severe: shrink-swell.	Severe: low strength, shrink-swell.	Severe: too clayey.
2---------- Barbarosa	Moderate: too clayey.	Severe: shrink-swell.	Severe: shrink-swell.	Severe: shrink-swell.	Severe: low strength, shrink-swell.	Slight.
3---------- Boerne	Moderate: floods.	Severe: floods.	Severe: floods.	Severe: floods.	Severe: floods.	Moderate: excess lime.
4*---------- Brackett	Severe: depth to rock.	Moderate: depth to rock.	Severe: depth to rock.	Moderate: slope, depth to rock.	Severe: low strength.	Severe: thin layer.
5:*						
Brackett----------	Severe: depth to rock, slope.	Severe: slope.	Severe: depth to rock, slope.	Severe: slope.	Severe: low strength, slope.	Severe: slope, thin layer.
Real----------	Severe: depth to rock, slope.	Severe: slope.	Severe: depth to rock, slope.	Severe: slope.	Severe: slope.	Severe: small stones, slope, thin layer.
6, 7---------- Denton	Moderate: depth to rock, too clayey.	Severe: shrink-swell.	Severe: shrink-swell.	Severe: shrink-swell.	Severe: low strength, shrink-swell.	Severe: too clayey.
8---------- Doss	Severe: depth to rock.	Moderate: shrink-swell, depth to rock.	Severe: depth to rock.	Moderate: shrink-swell, depth to rock.	Severe: low strength.	Severe: thin layer.
9:*						
Doss----------	Severe: depth to rock.	Moderate: shrink-swell, depth to rock.	Severe: depth to rock.	Moderate: shrink-swell, depth to rock.	Severe: low strength.	Severe: thin layer.
Brackett----------	Severe: depth to rock.	Moderate: depth to rock.	Severe: depth to rock.	Moderate: depth to rock.	Severe: low strength.	Severe: thin layer.
10:*						
Eckrant----------	Severe: depth to rock, large stones.	Severe: depth to rock, large stones.	Severe: depth to rock, large stones.	Severe: depth to rock, large stones.	Severe: depth to rock, large stones.	Severe: large stones, thin layer.
Comfort----------	Severe: depth to rock, large stones.	Severe: depth to rock, large stones.	Severe: depth to rock, large stones.	Severe: depth to rock, large stones.	Severe: depth to rock, large stones.	Severe: large stones, thin layer, too clayey.
11:*						
Eckrant----------	Severe: depth to rock, large stones.	Severe: depth to rock, large stones.	Severe: depth to rock, large stones.	Severe: slope, depth to rock, large stones.	Severe: depth to rock, large stones.	Severe: large stones, thin layer.
Rock outcrop.						
12, 13---------- Krum	Moderate: too clayey.	Severe: shrink-swell.	Severe: shrink-swell.	Severe: shrink-swell.	Severe: low strength, shrink-swell.	Severe: too clayey.

See footnote at end of table.

TABLE 10.--BUILDING SITE DEVELOPMENT--Continued

Map symbol and soil name	Shallow excavations	Dwellings without basements	Dwellings with basements	Small commercial buildings	Local roads and streets	Lawns and landscaping
14, 15---------- Nuvalde	Slight---------	Severe: shrink-swell.	Moderate: shrink-swell.	Severe: shrink-swell.	Severe: low strength, shrink-swell.	Severe: too clayey.
16---------- Oakalla	Moderate: floods.	Severe: floods.	Severe: floods.	Severe: floods.	Severe: low strength, floods.	Moderate: floods, excess lime.
17:* Orif----------	Moderate: floods.	Severe: floods.	Severe: floods.	Severe: floods.	Severe: floods.	Severe: small stones, droughty, floods.
Boerne----------	Moderate: floods.	Severe: floods.	Severe: floods.	Severe: floods.	Severe: floods.	Severe: floods, excess lime.
18---------- Tarpley	Severe: depth to rock.	Severe: shrink-swell, depth to rock.	Severe: depth to rock, shrink-swell.	Severe: shrink-swell, depth to rock.	Severe: depth to rock, low strength, shrink-swell.	Severe: thin layer.
19:* Tarpley----------	Severe: depth to rock.	Severe: shrink-swell, depth to rock.	Severe: depth to rock, shrink-swell.	Severe: shrink-swell, depth to rock.	Severe: depth to rock, low strength, shrink-swell.	Severe: thin layer.
Comfort----------	Severe: depth to rock, large stones.	Severe: depth to rock, large stones.	Severe: depth to rock, large stones.	Severe: depth to rock, large stones.	Severe: depth to rock, large stones.	Severe: large stones, thin layer, too clayey.

* See description of the map unit for composition and behavior characteristics of the map unit.

TABLE 11.--SANITARY FACILITIES

[Some terms that describe restrictive soil features are defined in the Glossary. See text for definitions of "slight," "moderate," "good," and "fair"]

Map symbol and soil name	Septic tank absorption fields	Sewage lagoon areas	Trench sanitary landfill	Area sanitary landfill	Daily cover for landfill
1--- Anhalt	Severe: depth to rock, percs slowly.	Severe: depth to rock.	Severe: depth to rock, too clayey.	Severe: depth to rock.	Poor: area reclaim, too clayey, hard to pack.
2--- Barbarosa	Severe: percs slowly.	Slight---	Severe: too clayey.	Slight---	Poor: too clayey, hard to pack.
3--- Boerne	Severe: floods.	Severe: seepage, floods.	Severe: floods, seepage.	Severe: floods, seepage.	Fair: excess lime.
4*--- Brackett	Severe: depth to rock.	Severe: depth to rock.	Severe: depth to rock.	Severe: depth to rock.	Poor: area reclaim, small stones.
5:*					
Brackett---	Severe: depth to rock, slope.	Severe: depth to rock, slope.	Severe: depth to rock, slope.	Severe: depth to rock, slope.	Poor: area reclaim, small stones, slope.
Real---	Severe: depth to rock, slope.	Severe: depth to rock, slope.	Severe: depth to rock, slope.	Severe: depth to rock, slope.	Poor: area reclaim, small stones, slope.
6, 7--- Denton	Severe: depth to rock, percs slowly.	Severe: depth to rock.	Severe: depth to rock, too clayey.	Severe: depth to rock.	Poor: area reclaim, too clayey, hard to pack.
8--- Doss	Severe: depth to rock, percs slowly.	Severe: depth to rock.	Severe: depth to rock, too clayey.	Severe: depth to rock.	Poor: area reclaim, too clayey, hard to pack.
9:*					
Doss---	Severe: depth to rock, percs slowly.	Severe: depth to rock.	Severe: depth to rock, too clayey.	Severe: depth to rock.	Poor: area reclaim, too clayey, hard to pack.
Brackett---	Severe: depth to rock.	Severe: depth to rock.	Severe: depth to rock.	Severe: depth to rock.	Poor: area reclaim, small stones.
10:*					
Eckrant---	Severe: depth to rock, large stones.	Severe: depth to rock, large stones.	Severe: depth to rock, large stones.	Severe: depth to rock.	Poor: area reclaim, large stones, thin layer.
Comfort---	Severe: depth to rock, large stones.	Severe: depth to rock, large stones.	Severe: depth to rock, large stones.	Severe: depth to rock.	Poor: too clayey, large stones, thin layer.

See footnote at end of table.

TABLE 11.--SANITARY FACILITIES--Continued

Map symbol and soil name	Septic tank absorption fields	Sewage lagoon areas	Trench sanitary landfill	Area sanitary landfill	Daily cover for landfill
11:*					
Eckrant	Severe: depth to rock, large stones.	Severe: depth to rock, slope, large stones.	Severe: depth to rock, large stones.	Severe: depth to rock.	Poor: area reclaim, large stones, thin layer.
Rock outcrop.					
12, 13--- Krum	Severe: percs slowly.	Moderate: slope.	Severe: too clayey.	Slight	Poor: too clayey, hard to pack.
14--- Nuvalde	Moderate: percs slowly.	Moderate: seepage.	Moderate: too clayey.	Slight	Fair: too clayey, hard to pack.
15--- Nuvalde	Moderate: percs slowly.	Moderate: seepage, slope.	Moderate: too clayey.	Slight	Fair: too clayey, hard to pack.
16--- Oakalla	Severe: floods.	Severe: floods.	Severe: floods.	Severe: floods.	Fair: too clayey.
17:*					
Orif	Severe: floods, poor filter.	Severe: seepage, floods, too sandy.	Severe: floods, seepage.	Severe: floods, seepage.	Poor: seepage, too sandy, small stones.
Boerne	Severe: floods.	Severe: seepage, floods.	Severe: floods, seepage.	Severe: floods, seepage.	Good.
18--- Tarpley	Severe: depth to rock, percs slowly.	Severe: depth to rock.	Severe: depth to rock.	Severe: depth to rock.	Poor: area reclaim, too clayey, thin layer.
19:*					
Tarpley	Severe: depth to rock, percs slowly.	Severe: depth to rock.	Severe: depth to rock.	Severe: depth to rock.	Poor: area reclaim, too clayey, thin layer.
Comfort	Severe: depth to rock, large stones.	Severe: depth to rock, large stones.	Severe: depth to rock, large stones.	Severe: depth to rock.	Poor: too clayey, large stones, thin layer.

* See description of the map unit for composition and behavior characteristics of the map unit.

TABLE 12.--CONSTRUCTION MATERIALS

[Some terms that describe restrictive soil features are defined in the Glossary. See text for definitions of "good," "fair," "poor," "probable," and "improbable"]

Map symbol and soil name	Roadfill	Sand	Gravel	Topsoil
1--- Anhalt	Poor: area reclaim, low strength, shrink-swell.	Improbable: excess fines.	Improbable: excess fines.	Poor: too clayey.
2--- Barbarosa	Poor: low strength, shrink-swell.	Improbable: excess fines.	Improbable: excess fines.	Fair: too clayey, small stones.
3--- Boerne	Fair: low strength.	Improbable: excess fines.	Improbable: excess fines.	Poor: excess lime.
4*--- Brackett	Poor: area reclaim, low strength, thin layer.	Improbable: excess fines.	Improbable: excess fines.	Poor: area reclaim, small stones.
5:*				
Brackett---	Poor: area reclaim, low strength, thin layer.	Improbable: excess fines.	Improbable: excess fines.	Poor: area reclaim, small stones, slope.
Real---	Poor: area reclaim, thin layer.	Improbable: excess fines, thin layer.	Improbable: excess fines, thin layer.	Poor: area reclaim, small stones, thin layer.
6, 7--- Denton	Poor: area reclaim, low strength, shrink-swell.	Improbable: excess fines.	Improbable: excess fines.	Poor: too clayey, small stones.
8--- Doss	Poor: area reclaim, low strength.	Improbable: excess fines, thin layer.	Improbable: excess fines, thin layer.	Poor: area reclaim, thin layer, excess lime.
9:*				
Doss---	Poor: area reclaim, low strength.	Improbable: excess fines, thin layer.	Improbable: excess fines, thin layer.	Poor: area reclaim, thin layer, excess lime.
Brackett---	Poor: area reclaim, low strength, thin layer.	Improbable: excess fines.	Improbable: excess fines.	Poor: area reclaim, small stones.
10:*				
Eckrant---	Poor: area reclaim, thin layer, large stones.	Improbable: excess fines, thin layer, large stones.	Improbable: excess fines, thin layer, large stones.	Poor: area reclaim, large stones, thin layer.
Comfort---	Poor: thin layer, large stones.	Improbable: excess fines.	Improbable: excess fines.	Poor: too clayey, large stones, thin layer.

See footnote at end of table.

TABLE 12.--CONSTRUCTION MATERIALS--Continued

Map symbol and soil name	Roadfill	Sand	Gravel	Topsoil
11:*				
Eckrant	Poor: area reclaim, thin layer, large stones.	Improbable: excess fines, thin layer, large stones.	Improbable: excess fines, thin layer, large stones.	Poor: area reclaim, large stones, thin layer.
Rock outcrop.				
12, 13---- Krum	Poor: low strength, shrink-swell.	Improbable: excess fines.	Improbable: excess fines.	Poor: too clayey.
14, 15---- Nuvalde	Poor: low strength, shrink-swell.	Improbable: excess fines.	Improbable: excess fines.	Poor: too clayey.
16---- Oakalla	Poor: low strength.	Improbable: excess fines.	Improbable: excess fines.	Fair: too clayey, excess lime.
17:*				
Orif	Good	Improbable: small stones, excess fines.	Probable	Poor: small stones, area reclaim, excess lime.
Boerne	Fair: low strength.	Improbable: excess fines.	Improbable: excess fines.	Poor: excess lime.
18---- Tarpley	Poor: area reclaim, low strength, thin layer.	Improbable: excess fines, thin layer.	Improbable: excess fines, thin layer.	Poor: area reclaim, thin layer.
19:*				
Tarpley	Poor: area reclaim, low strength, thin layer.	Improbable: excess fines.	Improbable: excess fines.	Poor: area reclaim, large stones, thin layer.
Comfort	Poor: thin layer, large stones.	Improbable: excess fines.	Improbable: excess fines.	Poor: too clayey, large stones, thin layer.

* See description of the map unit for composition and behavior characteristics of the map unit.

TABLE 13.--WATER MANAGEMENT

[Some terms that describe restrictive soil features are defined in the Glossary. See text for definitions of "slight," "moderate," and "severe"]

Map symbol and soil name	Limitations for--		Features affecting--		
	Pond reservoir areas	Embankments, dikes, and levees	Irrigation	Terraces and diversions	Grassed waterways
1---------- Anhalt	Severe: seepage.	Severe: hard to pack.	Slow intake, percs slowly, depth to rock	Depth to rock, percs slowly.	Depth to rock, percs slowly.
2---------- Barbarosa	Moderate: seepage.	Slight---------	Slow intake, percs slowly.	Percs slowly	Percs slowly.
3---------- Boerne	Severe: seepage.	Slight---------	Excess lime---	Floods--------	Favorable.
4*---------- Brackett	Severe: depth to rock.	Severe: thin layer.	Depth to rock, slope.	Large stones, depth to rock	Large stones, depth to rock.
5:* Brackett---------	Severe: depth to rock, slope.	Severe: thin layer.	Depth to rock, slope.	Large stones, slope, depth to rock	Large stones, slope, depth to rock.
Real----------	Severe: depth to rock, slope, seepage.	Severe: thin layer, seepage.	Droughty, depth to rock excess lime.	Slope, depth to rock	Slope, depth to rock.
6---------- Denton	Moderate: depth to rock.	Severe: hard to pack.	Slow intake, percs slowly, depth to rock	Depth to rock, percs slowly.	Depth to rock, percs slowly.
7---------- Denton	Moderate: depth to rock, slope.	Severe: hard to pack.	Slow intake, percs slowly, depth to rock	Depth to rock, percs slowly.	Depth to rock, percs slowly.
8---------- Doss	Severe: depth to rock, seepage.	Severe: thin layer.	Depth to rock, slope.	Depth to rock	Depth to rock.
9:* Doss----------	Severe: depth to rock, seepage.	Severe: thin layer.	Depth to rock, slope.	Depth to rock	Depth to rock.
Brackett---------	Severe: depth to rock.	Severe: thin layer.	Depth to rock, slope.	Large stones, depth to rock	Large stones, depth to rock.
10:* Eckrant----------	Severe: depth to rock, seepage.	Severe: thin layer, large stones.	Large stones, droughty, depth to rock	Large stones, depth to rock	Large stones, depth to rock.
Comfort----------	Severe: depth to rock.	Severe: thin layer, large stones.	Large stones, slow intake, depth to rock	Large stones, depth to rock percs slowly.	Large stones. depth to rock, percs slowly.
11:* Eckrant----------	Severe: depth to rock, seepage.	Severe: thin layer, large stones.	Large stones, droughty, depth to rock	Slope, large stones, depth to rock	Large stones. slope, depth to rock.
Rock outcrop.					
12---------- Krum	Slight---------	Severe: hard to pack.	Slow intake---	Favorable-----	Favorable.
13---------- Krum	Moderate: slope.	Severe: hard to pack.	Slow intake, slope.	Favorable-----	Favorable.

See footnote at end of table.

TABLE 13.--WATER MANAGEMENT--Continued

Map symbol and soil name	Limitations for--		Features affecting--		
	Pond reservoir areas	Embankments, dikes, and levees	Irrigation	Terraces and diversions	Grassed waterways
14, 15---------- Nuvalde	Severe: seepage.	Moderate: hard to pack.	Slow intake---	Favorable-----	Favorable.
16---------- Oakalla	Moderate: seepage.	Moderate: hard to pack.	Floods, excess lime.	Floods--------	Favorable.
17:*					
Orif----------	Severe: seepage.	Severe: seepage.	Droughty, fast intake, floods.	Small stones	Droughty.
Boerne----------	Severe: seepage.	Slight---------	Floods, excess lime.	Floods--------	Favorable.
18---------- Tarpley	Severe: depth to rock, seepage.	Severe: thin layer.	Percs slowly, depth to rock	Depth to rock, percs slowly.	Depth to rock, percs slowly.
19:*					
Tarpley----------	Severe: depth to rock, seepage.	Severe: thin layer.	Large stones, percs slowly, depth to rock	Large stones, depth to rock, percs slowly.	Large stones, depth to rock, percs slowly.
Comfort----------	Severe: depth to rock.	Severe: thin layer, large stones.	Large stones, slow intake, depth to rock	Large stones, depth to rock, percs slowly.	Large stones, depth to rock, percs slowly.

* See description of the map unit for composition and behavior characteristics of the map unit.

TABLE 14.--ENGINEERING INDEX PROPERTIES

[The symbol < means less than; > means more than. Absence of an entry indicates that data were not estimated]

Map symbol and soil name	Depth	USDA texture	Classification		Fragments > 3 inches	Percentage passing sieve number--				Liquid limit	Plasticity index
			Unified	AASHTO		4	10	40	200		
	In				Pct					Pct	
1----------	0-7	Clay----------	CH	A-7-6	0-10	85-100	85-100	85-100	80-100	51-70	35-53
Anhalt	7-29	Clay----------	CH	A-7-6	0-10	85-100	85-100	85-100	80-95	68-88	45-62
	29-30	Unweathered bedrock.	---	---	---	---	---	---	---	---	---
2----------	0-11	Silty clay loam--	CH, CL	A-7-6	0	100	85-100	85-100	80-95	45-65	25-40
Barbarosa	11-48	Clay, silty clay	CH	A-7-6	0	100	85-100	85-100	80-95	55-70	30-40
	48-63	Clay, silty clay	CH	A-7-6	0	80-95	75-90	70-85	60-75	51-65	27-37
3----------	0-60	Fine sandy loam, loam.	CL, SC, CL-ML, SM-SC	A-4, A-6	0-5	85-100	75-100	70-95	38-75	25-35	4-15
Boerne											
4*----------	0-17	Gravelly clay loam, clay loam.	CL, SC, GC	A-6, A-4, A-7-6	0-20	70-100	60-100	54-95	40-85	28-45	9-26
Brackett	17-30	Weathered bedrock	---	---	---	---	---	---	---	---	---
5:*											
Brackett--------	0-14	Gravelly clay loam, clay loam.	CL, SC, GC	A-6, A-4, A-7-6	0-20	70-100	60-100	54-95	40-85	28-45	9-26
	14-30	Weathered bedrock	---	---	---	---	---	---	---	---	---
Real----------	0-14	Gravelly clay loam, very gravelly clay loam.	GC, SC, GP-GC, SP-SC	A-2-6, A-2-4	1-70	25-75	10-50	10-45	10-35	25-35	8-15
	14-60	Variable, weathered bedrock.	---	---	---	---	---	---	---	---	---
6, 7----------	0-24	Silty clay-------	CH, CL	A-7-6	0-10	80-100	80-100	80-100	75-95	49-70	26-45
Denton	24-39	Silty clay, clay, silty clay loam.	CH, CL	A-7-6	0-20	80-100	80-100	80-100	70-95	41-60	21-40
	39-41	Weathered bedrock	---	---	---	---	---	---	---	---	---
8----------	0-18	Silty clay-------	CL, CH	A-7-6	0-20	84-100	81-100	75-100	61-95	41-61	20-39
Doss	18-30	Unweathered bedrock.	---	---	---	---	---	---	---	---	---
9:*											
Doss----------	0-18	Silty clay-------	CL, CH	A-7-6	0-20	84-100	81-100	75-100	61-95	41-61	20-39
	18-30	Unweathered bedrock.	---	---	---	---	---	---	---	---	---
Brackett--------	0-14	Gravelly clay loam, clay loam.	CL, SC, GC	A-6, A-4, A-7-6	0-20	70-100	60-100	54-95	40-85	28-45	9-26
	14-60	Weathered bedrock	---	---	---	---	---	---	---	---	---
10:*											
Eckrant---------	0-5	Stony clay-------	GC, SC, CH	A-7-6, A-2-7	25-75	45-98	40-98	35-97	30-94	51-76	31-54
	5-7	Unweathered bedrock.	---	---	---	---	---	---	---	---	---
Comfort---------	0-5	Stony clay-------	CH, GC, SC, CL	A-2-7, A-7-6	20-70	45-98	40-98	35-95	30-90	41-72	25-45
	5-17	Stony clay, very stony clay, extremely stony clay.	CH, GC, SC	A-7-6	30-70	45-98	40-98	35-97	30-95	60-90	43-65
	17-20	Unweathered bedrock.	---	---	---	---	---	---	---	---	---

See footnote at end of table.

TABLE 14.--ENGINEERING INDEX PROPERTIES--Continued

Map symbol and soil name	Depth	USDA texture	Classification		Fragments > 3 inches	Percentage passing sieve number--				Liquid limit	Plasticity index
			Unified	AASHTO		4	10	40	200		
	In				Pct					Pct	
11:*											
Eckrant	0-5	Stony clay	GC, SC, CH	A-7-6, A-2-7	25-75	45-98	40-98	35-97	30-94	51-76	31-54
	5-7	Unweathered bedrock.	---	---	---	---	---	---	---	---	---
Rock outcrop.											
12	0-21	Silty clay	CH, CL	A-7-6	0	95-100	85-100	85-100	78-95	47-65	25-42
Krum	21-40	Silty clay, clay	CH	A-7-6	0	95-100	85-100	80-100	65-95	51-74	28-50
	40-62	Silty clay loam, silty clay, clay.	CH, CL	A-7-6, A-6	0	85-100	75-100	70-99	65-95	36-62	20-41
13	0-42	Silty clay, clay	CH	A-7-6	0	95-100	85-100	80-100	65-95	51-74	28-50
Krum	42-60	Silty clay loam, silty clay, clay.	CH, CL	A-7-6, A-6	0	85-100	75-100	70-99	65-95	36-62	20-41
14, 15	0-12	Silty clay	CH, CL	A-7-6	0	95-100	95-100	90-100	85-96	46-62	25-40
Nuvalde	12-30	Clay loam, clay, silty clay.	CH, CL	A-7-6	0	95-100	95-100	90-100	80-98	42-58	24-40
	30-60	Clay loam, silty clay loam, clay.	CL	A-6, A-7-6	0	85-100	80-100	70-98	65-98	32-54	14-34
16	0-60	Silty clay loam	CL, CH	A-6, A-7-6	0-2	85-100	80-100	70-100	65-95	35-54	18-36
Oakalla											
17:*											
Orif	0-16	Gravelly sandy loam.	GM, GM-GC, SM, SM-SC	A-1-B, A-2-4	0-10	55-80	50-75	35-55	10-30	<20	NP-7
	16-60	Stratified very gravelly fine sandy loam to very gravelly loamy sand.	GW-GM, GM, SW-SM, SM	A-1-A, A-1-B	0-10	11-60	5-50	5-35	5-20	<20	NP-4
Boerne	0-60	Fine sandy loam, loam.	CL, SC, CL-ML, SM-SC	A-4, A-6	0-5	85-100	75-100	70-95	38-75	25-35	4-15
18	0-9	Clay	CL, CH	A-7-6	0-3	90-100	90-100	80-95	70-90	41-60	20-38
Tarpley	9-19	Clay	CH	A-7-6	0	90-100	90-100	90-100	65-98	70-90	45-60
	19-20	Unweathered bedrock.	---	---	---	---	---	---	---	---	---
19:*											
Tarpley	0-9	Stony clay	CL, CH	A-7-6	10-30	85-100	85-98	75-95	65-90	41-60	20-38
	9-19	Clay, cobbly clay	CH	A-7-6	0-15	85-100	85-100	85-100	60-95	70-90	45-60
	19-20	Unweathered bedrock.	---	---	---	---	---	---	---	---	---
Comfort	0-9	Stony clay	CH, GC, CL, SC	A-2-7, A-7-6	20-70	45-98	40-98	35-95	30-90	41-65	25-45
	5-17	Stony clay, very stony clay, extremely stony clay.	CH, GC, SC	A-7-6	30-70	45-98	40-98	35-97	30-95	60-90	45-65
	17-20	Unweathered bedrock.	---	---	---	---	---	---	---	---	---

* See description of the map unit for composition and behavior characteristics of the map unit.

TABLE 15.--PHYSICAL AND CHEMICAL PROPERTIES OF SOILS

[The symbol < means less than. Entries under "Erosion factors--T" apply to the entire profile. Entries under "Organic matter" apply only to the surface layer. Absence of an entry indicates that data were not available or were not estimated]

Map symbol and soil name	Depth	Clay <2mm	Permeability	Available water capacity	Soil reaction	Shrink-swell potential	Erosion factors		Organic matter
							K	T	
	In	Pct	In/hr	In/in	pH				Pct
1----------	0-7	35-50	<0.06	0.15-0.18	6.1-8.4	High----------	0.32	2	1-3
Anhalt	7-29	60-75	<0.06	0.15-0.18	6.1-8.4	Very high------	0.32		
	29-30	---	---	---	---	----------	---		
2----------	0-11	30-45	0.2-0.6	0.14-0.19	7.4-8.4	High----------	0.32	5	1-3
Barbarosa	11-48	40-60	0.06-0.2	0.14-0.19	7.9-8.4	High----------	0.32		
	48-63	35-50	0.2-0.6	0.14-0.19	7.9-8.4	High----------	0.32		
3----------	0-60	12-23	2.0-6.0	0.10-0.15	7.9-8.4	Low----------	0.28	5	0.5-1
Boerne									
4*----------	0-17	15-35	0.2-0.6	0.10-0.20	7.9-8.4	Low----------	0.32	2	<1
Brackett	17-30	---	---	---	---	----------	---		
5:*									
Brackett--------	0-14	15-35	0.2-0.6	0.10-0.20	7.9-8.4	Low----------	0.32	2	<1
	14-30	---	---	---	---	----------	---		
Real----------	0-14	18-35	0.6-2.0	0.05-0.10	7.9-8.4	Low----------	0.10	1	1-4
	14-60	---	---	---	---	----------	---		
6, 7----------	0-24	35-60	0.06-0.2	0.15-0.20	7.9-8.4	High----------	0.32	2	1-4
Denton	24-39	35-60	0.06-0.2	0.15-0.20	7.9-8.4	High----------	0.32		
	39-41	---	---	---	---	----------	---		
8----------	0-18	20-40	0.2-0.6	0.15-0.20	7.9-8.4	Moderate-------	0.24	1	1-3
Doss	18-30	---	---	---	---	----------	---		
9:*									
Doss----------	0-18	20-40	0.2-0.6	0.15-0.20	7.9-8.4	Moderate-------	0.24	1	1-3
	18-30	---	---	---	---	----------	---		
Brackett--------	0-14	15-35	0.2-0.6	0.10-0.20	7.9-8.4	Low----------	0.32	2	<1
	14-60	---	---	---	---	----------	---		
10:*									
Eckrant---------	0-5	40-60	0.2-0.6	0.05-0.12	6.6-8.4	Moderate-------	0.10	1	1-4
	5-7	---	---	---	---	----------	---		
Comfort---------	0-5	35-50	0.06-0.2	0.07-0.15	6.6-8.4	Low----------	0.10	1	1-4
	5-17	55-75	0.06-0.2	0.07-0.15	6.6-8.4	Moderate-------	0.10		
	17-20	---	---	---	---	----------	---		
11:*									
Eckrant---------	0-5	40-60	0.2-0.6	0.05-0.12	6.6-8.4	Moderate-------	0.10	1	1-4
	5-7	---	---	---	---	----------	---		
Rock outcrop.									
12----------	0-6	35-55	0.2-0.6	0.15-0.20	7.4-8.4	High----------	0.32	5	1-3
Krum	6-44	40-60	0.2-0.6	0.14-0.20	7.9-8.4	High----------	0.32		
	44-72	35-60	0.2-0.6	0.14-0.20	7.9-8.4	High----------	0.32		
13----------	0-42	40-60	0.2-0.6	0.14-0.20	7.9-8.4	High----------	0.32	5	1-3
Krum	42-60	35-60	0.2-0.6	0.14-0.20	7.9-8.4	High----------	0.32		
14, 15----------	0-12	35-50	0.6-2.0	0.14-0.20	7.9-8.4	High----------	0.28	5	1-3
Nuvalde	12-30	35-50	0.6-2.0	0.12-0.18	7.9-8.4	High----------	0.28		
	30-60	28-45	0.6-2.0	0.12-0.18	7.9-8.4	Moderate-------	0.32		
16----------	0-60	25-40	0.6-2.0	0.12-0.19	7.9-8.4	Moderate-------	0.32	5	1-3
Oakalla									

See footnote at end of table.

TABLE 15.--PHYSICAL AND CHEMICAL PROPERTIES OF SOILS--Continued

Map symbol and soil name	Depth	Clay <2mm	Permeability	Available water capacity	Soil reaction	Shrink-swell potential	Erosion factors		Organic matter
							K	T	
	In	Pct	In/hr	In/in	pH				Pct
17:*									
Orif	0-16	4-20	6.0-20	0.03-0.08	7.9-8.4	Low	0.10	5	<1
	16-60	5-18	6.0-20	0.03-0.08	7.9-8.4	Low	0.10		
Boerne	0-60	12-23	2.0-6.0	0.10-0.15	7.9-8.4	Low	0.28	5	0.5-1
18	0-9	30-50	0.2-0.6	0.15-0.20	6.1-7.8	High	0.32	1	1-3
Tarpley	9-19	60-80	0.06-0.2	0.12-0.18	6.1-7.8	Very high	0.32		
	19-20	---	---	---	---	---	---		
19:*									
Tarpley	0-9	30-50	0.2-0.6	0.10-0.16	6.1-7.8	High	0.32	1	1-3
	9-19	60-80	0.06-0.2	0.10-0.18	6.1-7.8	Very high	0.32		
	19-20	---	---	---	---	---	---		
Comfort	0-5	35-50	0.06-0.2	0.07-0.15	6.6-8.4	Low	0.10	1	1-4
	5-17	55-75	0.06-0.2	0.07-0.15	6.6-8.4	Moderate	0.10		
	17-20	---	---	---	---	---	---		

* See description of the map unit for composition and behavior characteristics of the map unit.

TABLE 16.--SOIL AND WATER FEATURES

[The definition of "flooding" in the text explains terms such as "common" and "brief." The symbol > means more than. Absence of an entry indicates that the feature is not a concern]

Map symbol and soil name	Hydrologic group	Flooding			High water table			Bedrock		Risk of corrosion	
		Frequency	Duration	Months	Depth	Kind	Months	Depth	Hardness	Uncoated steel	Concrete
					Ft			In			
1---------- Anhalt	D	None--------	---	---	>6.0	---	---	20-40	Hard	High-----	Low.
2---------- Barbarosa	D	None--------	---	---	>6.0	---	---	>60	---	High-----	Low.
3---------- Boerne	B	Common------	Brief-----	May-Sep	>6.0	---	---	>60	---	Moderate	Low.
4*---------- Brackett	C	None--------	---	---	>6.0	---	---	10-20	Soft	High-----	Low.
5:*											
Brackett---------	C	None--------	---	---	>6.0	---	---	10-20	Soft	High-----	Low.
Real----------	D	None--------	---	---	>6.0	---	---	8-20	Soft	High-----	Low.
6, 7---------- Denton	D	None--------	---	---	>6.0	---	---	22-40	Soft	High-----	Low.
8---------- Doss	C	None--------	---	---	>6.0	---	---	11-20	Soft	High-----	Low.
9:*											
Doss----------	C	None--------	---	---	>6.0	---	---	11-20	Soft	High-----	Low.
Brackett---------	C	None--------	---	---	>6.0	---	---	10-20	Soft	High-----	Low.
10:*											
Eckrant----------	D	None--------	---	---	>6.0	---	---	8-20	Hard	High-----	Low.
Comfort----------	D	None--------	---	---	>6.0	---	---	9-20	Hard	High-----	Low.
11:*											
Eckrant----------	D	None--------	---	---	>6.0	---	---	8-20	Hard	High-----	Low.
Rock outcrop.											
12, 13---------- Krum	D	None--------	---	---	>6.0	---	---	>60	---	High-----	Low.
14, 15---------- Nuvalde	B	None--------	---	---	>6.0	---	---	>60	---	High-----	Low.
16---------- Oakalla	B	Common------	Very brief	May-Sep	>6.0	---	---	>60	---	Moderate	Low.
17:*											
Orif----------	A	Common------	Very brief	Sep-Jun	>6.0	---	---	>60	---	Low------	Low.
Boerne----------	B	Common------	Very brief	May-Sep	>6.0	---	---	>60	---	Moderate	Low.
18---------- Tarpley	D	None--------	---	---	>6.0	---	---	13-20	Hard	High-----	Low.
19:*											
Tarpley----------	D	None--------	---	---	>6.0	---	---	13-20	Hard	High-----	Low.
Comfort----------	D	None--------	---	---	>6.0	---	---	9-20	Hard	High-----	Low.

* See description of the map unit for composition and behavior characteristics of the map unit.

TABLE 17.--ENGINEERING INDEX TEST DATA

[Analysis was conducted by the Material and Test Laboratory, State Department of Highways and Public Transportation, Austin, Texas]

Soil name, report number, horizon, and depth in inches	Classification		Grain size distribution									Liquid limit[2]	Plasticity index[2]	Moisture density	Shrinkage		
			Percentage passing sieve--							Percentage smaller than--							
	AASHTO	Unified	7/4 inch	5/8 inch	3/8 inch	No. 4	No. 10	No. 40	No. 200	.05 mm	.005 mm	.002 mm				Limit	Linear	Ratio
													Pct		G/cc	Pct	Pct	Pct
Boerne fsl:[3] (S72TX-130-004)																		
B2-------11 to 23	A-4 (00)	SC	100	100	100	100	100	87	40	34	21	14	25	9	2.69	16.0	4.7	1.8
Comfort st-c:[4] (S72TX-130-006)																		
A11-------0 to 8	A-7-6(21)	CH	100	63	62	62	62	61	56	47	27	20	72	44	2.59	11.0	22.5	1.8
B2t-------8 to 17	A-7-5(53)	CH	100	58	58	57	56	55	47	41	26	20	81	51	2.65	14.0	24.2	1.9
Comfort st-c:[5] (S72TX-130-007)																		
A1--------0 to 5	A-7-6(68)	CH	100	100	100	100	100	99	89	79	43	35	61	39	2.60	10.0	20.6	1.9
B2t-------5 to 12	A-7-6(56)	CH	100	100	80	80	80	79	70	64	39	31	66	43	2.65	9.0	22.7	2.0
Krum sic:[6] (S72TX-130-003)																		
Ap--------0 to 9	A-7-6(23)	CL-CH	100	100	99	99	99	96	78	70	39	31	50	30	2.63	14.0	16.2	1.9
A12-------9 to 21	A-7-6(35)	CH	100	100	100	100	100	98	87	79	52	45	60	37	2.68	12.0	19.7	1.9
B2--------21 to 45	A-7-6(38)	CH	100	100	100	100	99	96	86	80	55	47	62	41	2.68	11.0	20.7	1.9
Nuvalde sic:[7] (S72TX-130-005)																		
Ap--------0 to 6	A-7-6(28)	CH	100	100	100	100	100	99	87	76	38	26	53	30	2.64	14.0	16.8	1.8
B21------12 to 20	A-7-6(32)	CH	100	100	100	100	99	98	89	79	44	32	56	33	2.67	16.0	17.2	1.8
B22------20 to 30	A-7-6(31)	CH	100	100	99	98	97	95	86	74	46	36	54	34	2.70	15.0	16.9	1.8
Oakalla sic:[8] (S72TX-130-002)																		
A12-------8 to 17	A-7-6(24)	CH	100	100	100	100	99	91	77	64	36	24	53	30	2.64	15.0	16.3	1.8
B21------24 to 30	A-7-6(04)	SC	100	90	80	70	61	45	38	34	22	14	46	26	2.65	14.0	14.7	1.9
B22------30 to 44	A-7-6(16)	CL	100	100	99	95	90	82	74	68	46	32	42	23	2.69	14.0	13.3	1.9

[1]For soil materials larger than 3/8 inch, square mesh wire sieves were used that are slightly larger than equivalent round sieves, but these differences do not seriously affect the data.

[2]Liquid limit and plastic index values were determined by the AASHTO-89 and AASHTO-90 methods except that soil was added to water.

[3]Boerne fine sandy loam:
8.8 miles north of junction of U.S. Highway 87 and Farm Road 474, and 300 feet north of Guadalupe river in roadside cut.

[4]Comfort stony clay:
5.3 miles west of Interstate Highway 10 on Ranger Creek Road, north 300 feet, and west 60 feet.

[5]Comfort stony clay:
5.8 miles northeast of Bergheim on Edge Falls Road, and 84 feet east of road.

[6]Krum silty clay:
0.4 mile southeast of Interstate Highway 10 and U.S. Highway 87 in Comfort, and south 100 feet, in field.

[7]Nuvalde silty clay:
0.4 mile north of Waring, 1.7 miles east on county road, 300 feet north, and east 60 feet.

[8]Oakalla silty clay:
0.3 mile south of U.S. Highway 87 and Texas Highway 46 in Boerne, east 1 mile to Menger Creek, and 70 feet west of road.

TABLE 18.--CLASSIFICATION OF THE SOILS

[An asterisk in the first column indicates that the soil is a taxadjunct to the series. See text for a description of those characteristics of the soil that are outside the range of the series]

Soil name	Family or higher taxonomic class
Anhalt	Very-fine, montmorillonitic, thermic Udic Chromusterts
Barbarosa	Fine, montmorillonitic, thermic Udertic Paleustolls
Boerne	Coarse-loamy, carbonatic, thermic Fluventic Ustochrepts
Brackett	Loamy, carbonatic, thermic, shallow Typic Ustochrepts
Comfort	Clayey-skeletal, mixed, thermic Lithic Argiustolls
Denton	Fine, montmorillonitic, thermic Vertic Calciustolls
Doss	Loamy, carbonatic, thermic, shallow Typic Calciustolls
Eckrant	Clayey-skeletal, montmorillonitic, thermic Lithic Haplustolls
Krum	Fine, montmorillonitic, thermic Vertic Haplustolls
Nuvalde	Fine-silty, mixed, thermic Typic Calciustolls
Oakalla	Fine-loamy, carbonatic, thermic Cumulic Haplustolls
Orif	Sandy-skeletal, carbonatic, thermic Typic Ustifluvents
Real	Loamy-skeletal, carbonatic, thermic, shallow Typic Calciustolls
Tarpley	Clayey, montmorillonitic, thermic Lithic Vertic Argiustolls

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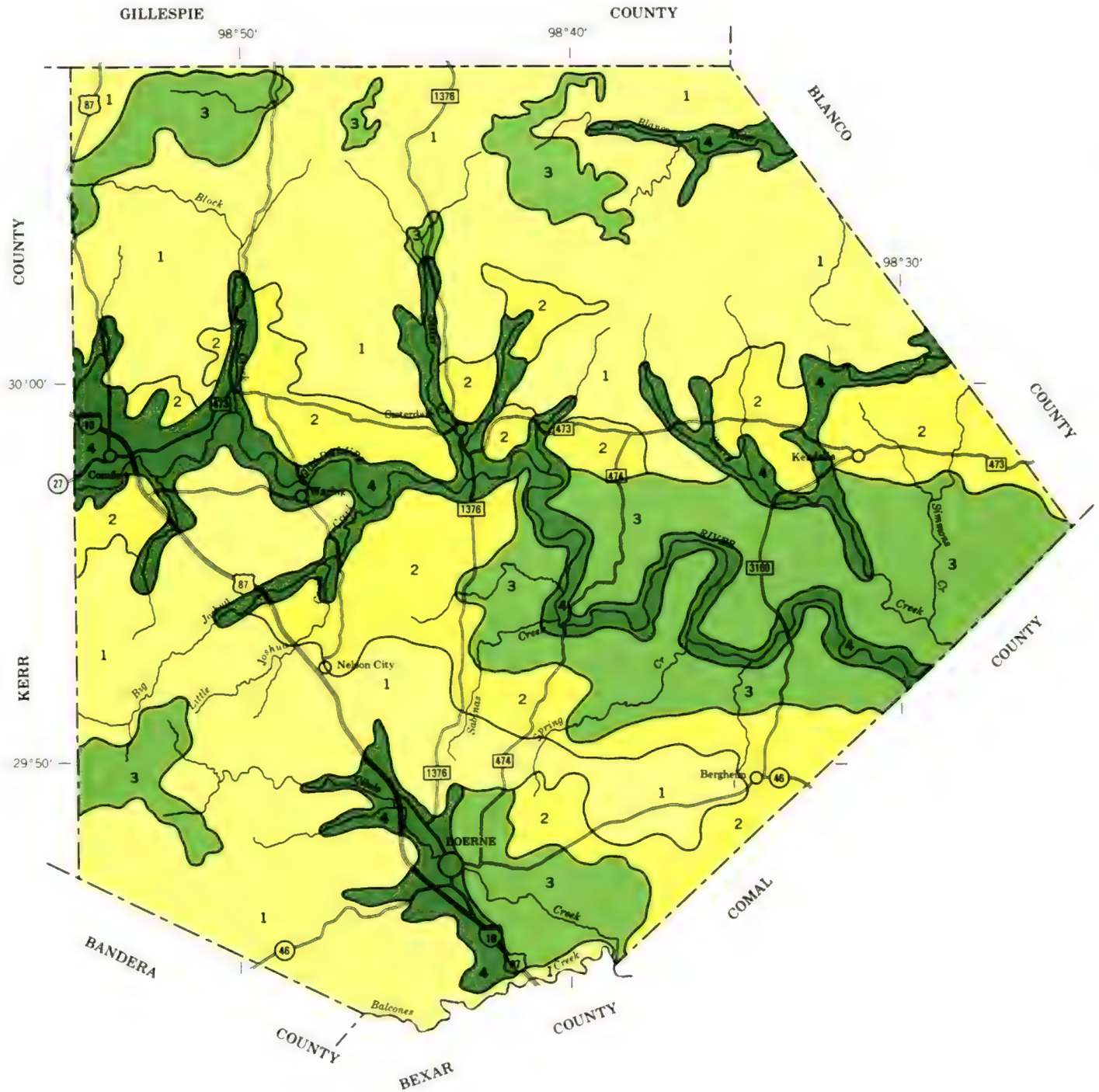


LEGEND

1 — BRACKETT-ECKRANT: Shallow and very shallow, undulating to hilly, loamy and clayey soils; most are gravelly or stony; on uplands

2 — DOSS-BRACKETT: Shallow, undulating, loamy and clayey soils; on uplands

3 — ECKRANT-COMFORT-TARPLEY: Very shallow and shallow, gently undulating, clayey soils, most are stony; on uplands

4 — OAKALLA-BOERNE-NUVALDE: Deep, nearly level to gently sloping, loamy and clayey soils; on flood plains and stream terraces

Compiled 1979

Each area outlined on this map consists of more than one kind of soil. The map is thus meant for general planning rather than a basis for decisions on the use of specific tracts

N

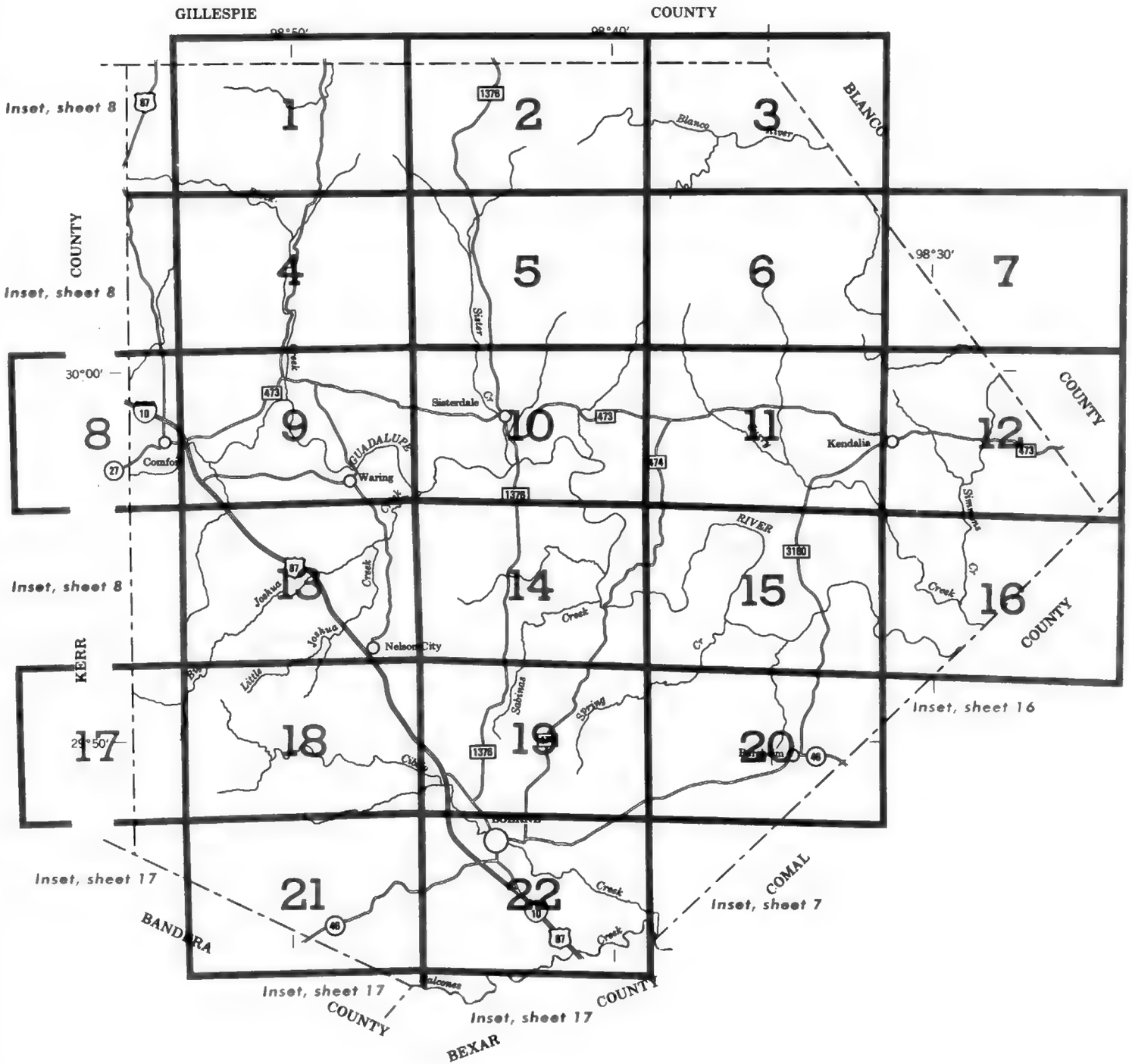
UNITED STATES DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE
TEXAS AGRICULTURAL EXPERIMENT STATION

GENERAL SOIL MAP

KENDALL COUNTY, TEXAS

1 0 1 2 3 4 Miles

1 0 4 8 Km


GILLESPIE
COUNTY
98°50'
98°40'
98°30'
30°00'
29°50'
Inset, sheet 8
Inset, sheet 8
COUNTY
1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
17
18
19
20
21
22
BLANCO
Blanco
Sisters
Creek
Sisterdale
Waring
Kendalia
Nelson City
Joshua
Little
Cibolo
Spring
Sabinas
RIVER
Simmons
COUNTY
Inset, sheet 16
KERR
Inset, sheet 17
BANDERA
Inset, sheet 17
COUNTY
Inset, sheet 17
BEXAR
COUNTY
COMAL
Inset, sheet 7
N
INDEX TO MAP SHEETS
KENDALL COUNTY, TEXAS
1 0 1 2 3 4 Miles
1 0 4 8 Km

CONVENTIONAL AND SPECIAL SYMBOLS LEGEND

CULTURAL FEATURES

BOUNDARIES

- National, state or province
- County or parish
- Minor civil division
- Reservation (national forest or park, state forest or park, and large airport)
- Land grant
- Limit of soil survey (label)
- Field sheet matchline & neatline
- AD HOC BOUNDARY (label)
- Small airport, airfield, park, oilfield, cemetery, or flood pool

STATE COORDINATE TICK

LAND DIVISION CORNERS (sections and land grants)

ROADS

- Divided (median shown if scale permits)
- Other roads
- Trail

ROAD EMBLEM & DESIGNATIONS

- Interstate
- Federal
- State
- County, farm or ranch

RAILROAD

POWER TRANSMISSION LINE (normally not shown)

PIPE LINE (normally not shown)

FENCE (normally not shown)

LEVEES

- Without road
- With road
- With railroad

DAMS

- Large (to scale)
- Medium or small

PITS

- Gravel pit
- Mine or quarry

MISCELLANEOUS CULTURAL FEATURES

- Farmstead, house (omit in urban areas)
- Church
- School
- Indian mound (label)
- Located object (label)
- Tank (label)
- Wells, oil or gas
- Windmill
- Kitchen midden

WATER FEATURES

DRAINAGE

- Perennial, double line
- Perennial, single line
- Intermittent
- Drainage end
- Canals or ditches
  - Double-line (label)
  - Drainage and/or irrigation

LAKES, PONDS AND RESERVOIRS

- Perennial
- Intermittent

MISCELLANEOUS WATER FEATURES

- Marsh or swamp
- Spring
- Well, artesian
- Well, irrigation
- Wet spot

SPECIAL SYMBOLS FOR SOIL SURVEY

SOIL DELINEATIONS AND SYMBOLS

ESCARPMENTS

- Bedrock (points down slope)
- Other than bedrock (points down slope)

SHORT STEEP SLOPE

GULLY

DEPRESSION OR SINK

SOIL SAMPLE SITE (normally not shown)

MISCELLANEOUS

- Blowout
- Clay spot
- Gravelly spot
- Gumbo, slick or scabby spot (sodic)
- Dumps and other similar non soil areas
- Prominent hill or peak
- Rock outcrop (includes sandstone and shale)
- Saline spot
- Sandy spot
- Severely eroded spot
- Slide or slip (tips point upslope)
- Stony spot, very stony spot

SOIL LEGEND

The map symbols are arabic numbers. The soil name followed by the superscript 1/designates a broadly defined mapping unit and the composition of these mapping units are more variable than other mapping units in the survey area. Mapping has been controlled well enough for the anticipated use of the soil.

SYMBOL	NAME
1	Anhalt clay, 1 to 3 percent slopes
2	Barbarosa silty clay loam, 0 to 1 percent slopes
3	Boerne fine sandy loam
4	Brackett association, undulating 1/
5	Brackett-Real association, hilly 1/
6	Denton silty clay, 1 to 3 percent slopes
7	Denton silty clay, 3 to 5 percent slopes
8	Doss silty clay, 1 to 5 percent slopes
9	Doss-Brackett association, undulating 1/
10	Eckrant-Comfort association, gently undulating 1/
11	Eckrant-Rock outcrop association, steep 1/
12	Krum silty clay, 1 to 3 percent slopes
13	Krum silty clay, 3 to 5 percent slopes
14	Nuvalde silty clay, 0 to 1 percent slopes
15	Nuvalde silty clay, 1 to 3 percent slopes
16	Oakalla silty clay loam
17	Orif-Boerne association, gently undulating 1/
18	Tarpley clay, 1 to 3 percent slopes
19	Tarpley-Comfort association, gently undulating 1/

KENDALL COUNTY, TEXAS — SHEET NUMBER 1

2 040 000 FEET

GILLESPIE COUNTY

GILLESPIE COUNTY

South Grape Creek

Bankersmith

South Creek

Elm Creek

No Name Bottom

BIG HILL

Rafter Hollow

Block Creek

(Joins inset C, sheet 8)

(Joins sheet 2)

(Joins sheet 4)

2 070 000 FEET

N

3 Miles

15000 Feet

10000

5000

Scale 1:31 680

This map is compiled on 1976 aerial photography by the U. S. Department of Agriculture Soil Conservation Service and cooperating agencies
Coordinate grid ticks and land division corners, if shown, are approximately positioned

KENDALL COUNTY, TEXAS — SHEET NUMBER 2

2

N

3 Miles 15000 Feet

2 10000

Scale 1:31680

1 5000

5000 4000 3000 2000 1000 0 0

2 110 000 FEET

840 000 FEET

GILLESPIE COUNTY

GILLESPIE COUNTY

Middle Fork

Frantz Branch

Hunters Creek

Meier Creek

Blanco River

Blanco Creek

Blackberry Creek

West Sister Creek

Wenzel Creek

1376

1888

1886

1876

820 000 FEET

2 080 000 FEET

(Joins sheet 1)

(Joins sheet 3)

(Joins sheet 5)

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Coordinate grid ticks and land division corners, if shown, are approximately positioned

KENDALL COUNTY, TEXAS — SHEET NUMBER 3

2 120 000 FEET

840 000 FEET

GILLESPIE COUNTY

BLANCO COUNTY

INDEFINITE

Lindendale

Blanco River

Blanco Creek

Delaware Creek

South Fork

Barker Hollow

Sleepy Hollow

Hog Hollow

1888

1889

(Joins sheet 2)

2 140 000 FEET

(Joins sheet 6)

3

N

3 Miles

15000 Feet

10000

5000

Scale 1:31 680

8700 000 FEET

KENDALL COUNTY, TEXAS — SHEET NUMBER 4

(4)

N

(Joins sheet 1)

2 070 000 FEET

8 810 000 FEET

(Joins inset 8, sheet 8)

800 000 FEET

(Joins sheet 9)

2 040 000 FEET

(Joins sheet 5)

Scale 1:31 680

3 Miles 2 1 0

15000 Feet 10000 5000

5000 4000 3000 2000 1000 0

Block Creek

Hollow

Reeh Creek

Ferrier Creek

Fig

Rock Creek

Polecat Spring

Creek

Block

Darmstadt

This map is compiled on 1974 aerial photography by the U. S. Department of Agriculture, Soil Conservation Service and cooperating agencies
Coordinate grid (1000-foot interval) based on Texas coordinate system, central zone (Lambert conformal conic projection)

KENDALL COUNTY, TEXAS — SHEET NUMBER 5

2 080 000 FEET

(Joins sheet 2)

(Joins sheet 4)

(Joins sheet 6)

(Joins sheet 10)

2 110 000 FEET

Jung

Reen

West Creek

Dunners Mountain

Plalle Creek

Sisler

Bust Buttes

Askey Creek

Lone Cave Hill

Willie Creek

Snell Creek

Haag Creek

Slater Creek

East Creek

Wolf Mountain

Cypress Creek

1376

N

3 Miles 2 1 0 1

15000 Feet 10000 5000 0

Scale 1:31 680

1 ¾ ½ ¼ 0

5000 4000 3000 2000 1000 0

This map was compiled on 1976 aerial photography by the U. S. Department of Agriculture Soil Conservation Service and cooperating agencies
Coordinate grid ticks and land division corners, if shown, are approximately positioned

KENDALL COUNTY, TEXAS — SHEET NUMBER 6

6

N

(Joins sheet 3)

2 150 000 FEET

(Joins sheet 5)

(Joins sheet 7)

12 120 000 FEET

(Joins sheet 11)

Barker Hollow

Sleepy Hollow

Blanco

South Fork Blanco

BLANCO COUNTY BOUNDARY

Creek

Crabapple

Meta Mountain

Curry

Sheps

Dry Creek

Creek

3 Miles

15000 Feet

10000

5000

Scale 1:31 680

5000 4000 3000 2000 1000 0 0 1

2 150 000 FEET

810 000 FEET

(Joins sheet 6)

BLANCO INDEFINITE BOUNDARY COUNTY

Manahan Creek

Blanco River

Little

(Joins sheet 12)

2 120 000 FEET

(Joins sheet 20)

710 000 FEET

(Joins sheet 22)

Postoak

COUNTY

COMAL

Cibolo Creek

Balcones Creek

BEXAR COUNTY

700 000 FEET

800 000 FEET

2 130 000 FEET

2 180 000 FEET

7

N

3 Miles

15000 Feet

10000

5000

Scale 1:31 680

KENDALL COUNTY, TEXAS — SHEET NUMBER 8

8

N

3 Miles 15000 Feet

2 10000

1 5000

Scale 1:31680

INSET A (Joins sheet 8)

INSET B (Joins inset C)

INSET C

(Joins inset B)

2 033000 FEET

2 028000 FEET

5000 AND 10000-FOOT GRID TICKS

KERR COUNTY

GILLESPIE COUNTY

Bruins Creek

North Creek

Creek

Rattlesnake Mountain

Bear Creek

Lee Creek

Turkey Hollow Creek

Block Creek

Mount Rigi

Gaddis Bluff

Cypress

Comfort

GUADALUPE RIVER

INDEFINITE

(Joins sheet 17)

(Joins sheet 13)

(Joins sheet 4)

(Joins sheet 8)

(Joins sheet 1)

(Joins inset B)

(Joins inset A)

(Join sheet 9)

This map is compiled on 1915 aerial photography by the U. S. Department of Agriculture. Soil Conservation Service and cooperating agencies. Coordinate grid ticks and land division corners, if shown, are approximately positioned

KENDALL COUNTY, TEXAS — SHEET NUMBER 9

(Joins sheet 4)

2 040 000 FEET

Schleicher Mountain

Flat Rock Creek

Block Creek

Darmsiadt Creek

First Coffee Hollow

Second Coffee Hollow

Coffee Hollow

GUADALUPE RIVER

Holliday Creek

Waring

Joshua Creek

(Joins sheet 8)

(Joins sheet 10)

(Joins sheet 13)

2 070 000 FEET

9

N

3 Miles

15 000 Feet

10 000

5 000

Scale 1:31 680

This map is compiled on 1975 aerial photography by the U. S. Department of Agriculture Soil Conservation Service and cooperating agencies.
Coordinate grid ticks and land division corners, if shown are approximately positioned

KENDALL COUNTY, TEXAS — SHEET NUMBER 10

10

N

(Joins sheet 5)

2 110 000 FEET

(Joins sheet 9)

Darmstadt Creek

West Sister Creek

Sisterdale

East Creek

Sister Creek

Cypress Creek

Warner Creek

Creek

GUADALUPE RIVER

Joshua Creek

Violet Creek

Jacobs Creek

Spicewood Canyon

GUADALUPE RIVER

2 080 000 FEET

(Joins sheet 14)

(Joins sheet 11)

3 Miles 15000 Feet 10000

Scale 1:31 680

5000 4000 3000 2000 1000 0 5000

This map is compiled on 1976 aerial photography by the U. S. Department of Agriculture. Soil Conservation Service and cooperating agencies
Coordinate grid ticks and land division corners, if shown, are approximately positioned

KENDALL COUNTY, TEXAS — SHEET NUMBER 11

2 120 000 FEET

(Joins sheet 6)

190 000 FEET

(Joins sheet 10)

(Joins sheet 12)

(Joins sheet 15)

2 150 000 FEET

Dry Creek

Currey Creek

Sheps Creek

Rawls Creek

Ross Creek

Round Mountain

Coyote Creek

Goss Creek

Canyon

Carlisle Canyon

Thornton Canyon

Big Spring Canyon

Curry Creek

Kendalia

473

474

3160

This map is compiled on 1976 aerial photography by the U. S. Department of Agriculture Soil Conservation Service and cooperating agencies
Coordinate grid ticks and land division corners, if shown, are approximately positioned

11

N

3 Miles

15000 Feet

10000

5000

Scale 1:31680

5000 4000 3000 2000 1000 0

KENDALL COUNTY, TEXAS — SHEET NUMBER 12

12

N

(Joins sheet 7)

2 180 000 FEET

790 000 FEET

(Joins sheet 11)

2 150 000 FEET

(Joins sheet 16)

Little Blanco River

BLANCO

INDEFINITE

Creek

Krause

Kendalia

473

Simmons Creek

Simmons Creek

Spring Branch

BOUNDARY

COUNTY

COMAL COUNTY

3 Miles 2 1 0

15000 Feet 10000 5000 0

Scale 1:31 680

5000 4000 3000 2000 1000 0

This map is compiled on 1975 aerial photography by the U. S. Department of Agriculture, Soil Conservation Service and cooperating agencies
Coordinate grid ticks and land division corners (shown are approximately positioned)

KENDALL COUNTY, TEXAS — SHEET NUMBER 13

13

N

2 040 000 FEET

760 000 FEET

(Joins sheet 9)

(Joins inset A, sheet 8)

(Joins sheet 14)

(Joins sheet 18)

2 070 000 FEET

745 000 FEET

Jungfrau

Joshua Creek

Big Joshua Creek

Little Joshua Creek

Zinke Creek

Welfare

Ring Mountain

Nelson City

Cedar Mountain

Allen Creek

Little Creek

Creek

3 Miles

15 000 Feet

10 000

5 000

Scale 1:31 680

This map is compiled on 1976 aerial photography by the U. S. Department of Agriculture. Soil Conservation Service and cooperating agencies
Coordinate grid ticks and land division corners, if shown, are approximately positioned

14

N

(Joins sheet 10)

(Joins sheet 13)

(Joins sheet 19)

(Joins sheet 15)

2 110 000 FEET

2 080 000 FEET

740 000 FEET

Scale 1:31 680

3 Miles 15000 Feet 10000 5000

Violet Creek

Wasp Creek

Wasp Creek

GUADALUPE RIVER

Sabinas Creek

Tinnin Airfield (Private)

This map is compiled on 1954 aerial photographs by the U. S. Department of Agriculture, Soil Conservation Service and cooperating agencies.
Coordinate grid ticks and land division corners, if shown, are approximately positioned.

KENDALL COUNTY, TEXAS — SHEET NUMBER 15

15

N

2 120 000 FEET

(Joins sheet 11)

1 760 000 FEET

(Joins sheet 14)

(Joins sheet 16)

(Joins sheet 20)

2 150 000 FEET

1 740 000 FEET

3 Miles

15 000 Feet

10 000

5 000

Scale 1:31 680

This map is compiled on 1974 aerial photography by the U. S. Department of Agriculture Soil Conservation Service and cooperating agencies.
Roads, if shown, are approximately positioned
Coordinate grid ticks and land division corners, if shown, are approximately positioned

RIVER

GUADALUPE

Creek

Canyon

Spring

Hollow

Heiligmann

Elm

Big

Thornton

Carlisle

Coyote

Cross

Swede

Panther

KENDALL COUNTY, TEXAS — SHEET NUMBER 16

16

N

(Joins sheet 12)

2 180 000 FEET

(Joins sheet 15)

740 000 FEET

760 000 FEET

Curry Creek

Double U Ranch Airfield (Private)

Spring Branch

COUNTY

Simmons Creek

COMAL

GUADALUPE RIVER

Walter Creek

2 150 000 FEET

(Joins inset)

(Joins lower left)

2 160 000 FEET

(Joins sheet 20)

731 000 FEET

736 000 FEET

2 150 000 FEET

5000-FOOT GRID TICKS

3 Miles 15 000 Feet

2 10000

1 5000

Scale 1:31 680

5000 4000 3000 2000 1000 0

This map is compiled on 1976 aerial photography by the U. S. Department of Agriculture, Soil Conservation Service and cooperating agencies
Coordinate grid ticks and land division corners, if shown, are approximately positioned

KENDALL COUNTY, TEXAS — SHEET NUMBER 17

17

N

2 000 000 FEET

730 000 FEET

(Joins sheet 17)

INSET A

KERR COUNTY BOUNDARY

INDEFINITE

BANDERA COUNTY BOUNDARY

(Joins sheet 21)

5000-FOOT GRID TICKS

(Joins inset A, sheet 8)

Big Joshua Creek

Turkey Knob

(Joins sheet 18)

INSET B

(Joins sheet 21)

2 065 000 FEET

BANDERA COUNTY

BEXAR COUNTY

(Joins inset C.)

683 000 FEET

3000 AND 5000-FOOT GRID TICKS

INSET C

(Joins sheet 22)

2 080 000 FEET

(Joins inset B)

Balcones Creek

BEXAR COUNTY

2 090 000 FEET

3000 AND 10 000-FOOT GRID TICKS

(Joins inset A)

2 030 000 FEET

3 Miles

15 000 Feet

10 000

5000

Scale 1:31 680

This map is compiled on 1976 aerial photography by the U. S. Department of Agriculture, Soil Conservation Service and cooperating agencies.
Coordinate grid ticks and land division corners, if shown, are approximately positioned.

18

N

3 Miles 2 1 0

15000 Feet 10000 5000

Scale 1:31680

(Joins sheet 17)

(Joins sheet 19)

(Joins sheet 21)

Cedar Mountain

Spanish Pass

Cannon Hill

Bergmann Airfield (Private)

Cibolo Creek

Ranger Creek

This map is compiled on 1934 aerial photographs by the U.S. Department of Agriculture. Soil Conservation Service and cooperating agencies. Good data grid ticks and solid division corners. Datum are approximately positioned.

KENDALL COUNTY, TEXAS — SHEET NUMBER 19

19

N

2 080 000 FEET

(Joins sheet 14)

(Joins sheet 18)

(Joins sheet 20)

(Joins sheet 22)

730 000 FEET

720 000 FEET

2 110 000 FEET

Sabinas Mountain

Sabinas Creek

Smith Hill

Spring Creek

Malikoff Hill

Cibolo Creek

Cibolo

Boerne Creek

Cibolo Creek

BOERNE
(county seat)

Cibolo Creek

Post Oak Creek

3 Miles

15000 Feet

2

10000

1

Scale 1:31 680

5000

This map is compiled on 1975 aerial photography by the U. S. Department of Agriculture, Soil Conservation Service and cooperating agencies.
Coordinate grid ticks and land division corners, if shown, are approximately positioned.

20

N

(Joins sheet 15)

2 150 000 FEET

(Joins sheet 19)

730 000 FEET

(Joins inset, sheet 16)

720 000 FEET

2 120 000 FEET

(Joins inset, sheet 7)

Spring Creek

Black Creek

Swede Creek

Parlin Creek

Pleasant Valley

Bergheim

3160

4076

COMAL COUNTY

3 Miles

15000 Feet

10000

5000

Scale 1:31680

5000 4000 3000 2000 1000 0

¼ ¾ ½ ¼ 0

1 2 1

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KENDALL COUNTY, TEXAS — SHEET NUMBER 21

2 040 000 FEET

(Joins sheet 18)

21

N

710 000 FEET

(Joins inset A, sheet 17)

Creek

Frederick

Pipe

Creek

Creek

Lake Oz

Frederick

Creek

Creek

476

BANDERA

INDEFINITE

COUNTY

BOUNDARY

476

Deep

Hollow

(Joins sheet 22)

690 000 FEET

(Joins inset B, sheet 17)

2 070 000 FEET

3 Miles

15000 Feet

10000

5000

Scale 1:31 680

5000 4000 3000 2000 1000 0

1 ¾ ½ ¼ 0

This map is compiled on 1976 aerial photography by the U. S. Department of Agriculture, Soil Conservation Service and cooperating agencies.
Coordinate grid ticks and land division corners, if shown, are approximately positioned.

22

N

(Joins sheet 19)

2 110 000 FEET

710 000 FEET

BOERNE
(county seat)

Cibolo Creek

Frederick Creek

Menger Creek

Browns Creek

Cibolo Creek

Kirschke Ranch Airfield (Private)

Postoak Creek

Creek

BEXAR COUNTY

Balcones Creek

(Joins sheet 21)

690 000 FEET

2 080 000 FEET

(Joins inset C, sheet 17)

(Joins inset, sheet 7)

3 Miles 2 1 0

15 000 Feet 10 000 5 000 0

Scale 1:31 680

1 ¾ ½ ¼ 0

5000 4000 3000 2000 1000 0

This map is compiled on 1975 aerial photography by the U. S. Department of Agriculture, Soil Conservation Service and cooperating agencies.
Coordinate grid ticks and land division corners, if shown, are approximately positioned.